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Engineering and social responsibility: Challenges and opportunities in high education

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Abstract. - This study focuses on analyzing university social responsibility in the training of engineers. Engineering students were surveyed and contrasted with social science students to relate higher education with social education. The research was a quantitative and descriptive approach using a non-experimental cross-sectional design. The sample comprised 1023 intentionally selected engineering and social science students. A specific validated scale was applied to assess students' perception of their social responsibility in the university context and ordinary life. The results indicated a medium level of social responsibility with a tendency to be low in the group of university students analyzed. In addition, it was observed that engineering careers should reinforce the social commitment of students.

Keywords: University social responsibility, engineering students, university careers.

Ingeniería y responsabilidad social: Retos y oportunidades en la educación superior

Resumen: Este estudio se enfoca en el análisis de la responsabilidad social universitaria en la formación de ingenieros. Para ello se analizaron estudiantes de ingeniería y se contrastó con estudiantes de ciencias sociales, esto con la finalidad de relacionar la educación universitaria con la educación social. La investigación tuvo un enfoque cuantitativo y descriptivo, utilizando un diseño no experimental de corte transversal. La muestra comprendió a 1023 estudiantes de ingeniería y ciencias sociales seleccionados de manera intencional. Se aplicó una escala validada específica para evaluar la percepción de los estudiantes en relación con su responsabilidad social en el contexto universitario y en la vida común. Los resultados indicaron un nivel medio de responsabilidad social con una tendencia a ser bajo en el grupo de estudiantes universitarios analizados. Además, se observó que las carreras de ingeniería deben reforzar el compromiso social de los estudiantes.

Palabras clave: Responsabilidad social universitaria, estudiantes de ingeniería, carreras universitarias.

I. INTRODUCTION

The fundamental objective of university social responsibility in engineering careers is training socially responsible engineers. This implies that, besides acquiring academic skills, students must develop attitudes toward the common good. Engineers must possess interpersonal skills, the ability to address challenges, and a deep understanding of reality. From the beginning of their university education, students are expected to assume the social responsibility of contributing to local development, an essential requirement in contemporary society[1]. This training is not exclusive to engineering but includes other professional areas, such as training in social sciences, where much emphasis is placed on this subject.

Incorporating social responsibility in the training of engineers is a significant challenge today. Some of the most prominent issues and challenges include[2]:

Lack of Curricular Integration: Social responsibility is treated in isolation or as optional rather than fully integrated into the curriculum in many engineering programs. This can lead to a perception that social responsibility is not essential to engineering training.

Lack of Clarity in Objectives: The objectives and goals of social responsibility in engineering education may not be clearly defined. Assessing whether students develop the necessary skills and values can be challenging without specific goals.

Exclusive Technical Focus: Often, the training of engineers focuses mainly on technical and scientific skills, leaving aside the social and ethical dimensions. This can lead to engineers lacking the necessary sensitivity to their actions' social and moral consequences.

Lack of Role Models: Students may lack examples of engineers who have significantly impacted social responsibility, making it difficult to identify with the concept and motivate them to engage in related activities.

Cultural Resistance: In some educational institutions and among some teachers, there may be resistance to including social responsibility in engineering training due to the perception that this could divert time and resources from technical aspects.

Poor Assessment and Measurement: Measuring progress in acquiring competencies in social responsibility can be challenging. The lack of practical assessment tools can make determining whether students are developing these skills difficult.

Resource Scarcity: Some institutions may lack the resources necessary to implement effective social responsibility programs in engineering education, such as trained staff, extracurricular activities, and community projects.

Superficial Motivation: Occasionally, students may engage in social responsibility activities by fulfilling an academic requirement rather than by genuine commitment, which reduces the actual impact of these activities.

Focus on Limited Social Problems: Sometimes, social responsibility in engineering training focuses on specific problems, such as environmental sustainability, leaving out other equally important aspects, such as social justice and human rights.

Challenges of Scale and Complexity: The social and environmental problems engineers face can be highly complex and large-scale. This can leave students feeling overwhelmed or insecure about how to address these challenges.

According to University Law No. 30220 [3], university social responsibility is an ethical and effective management tool that must have a significant impact on society, with the added value that future professionals are not only trained for the occupational market but also develop their skills for the common good, protecting the environment, attending to the welfare of the population and contributing to the generation of wealth, bases of an adequate, sustainable development within an administrative, legal framework [4].

Therefore, this work aims to analyze university social responsibility in the training of engineers. It is compared with students of social sciences, which, because it is a more humanistic career, could have a component in favor of social responsibility. In this way, it is intended to compare their socio-academic variables, evaluate the curricular contents, and explore the challenges of future professionals within their community.

II. ENGINEERING AND SOCIETY

Engineering careers have undergone a remarkable evolution over time, and today, they play an essential role in the development and advancement of society. This evolution and how engineering contributes to current progress is described below:

A. Evolution of Engineering Careers

Engineering has ancient roots, from the construction of the pyramids in Egypt to military engineering in ancient Rome. However, it was not considered a formalized discipline at the time. Later, the Industrial Revolution in the nineteenth century marked the beginning of modern engineering. Mechanical, civil, and electrical engineering, among others, began to develop as distinct disciplines. During the twentieth century, engineering diversified further with the creation of fields such as aerospace engineering, electronics, computer science, and biotechnology. Engineering continues to evolve today, with an increasing focus on technology, sustainability, and interdisciplinarity. This career has become essential in solving global problems, from the fight against climate change to developing advanced information technologies. In addition, the present engineers make crucial contributions to developing social improvements, such as contributions to medicine and civil life.

B. Current Contributions of Engineering Careers

Engineering drives the development of cutting-edge technologies in fields such as artificial intelligence, robotics, nanotechnology, and cybersecurity, transforming how we live and work. In addition, engineers are crucial in finding sustainable solutions to environmental and energy challenges. They work on renewable energy projects, green building design, and sustainable transport. Civil and transportation engineering are central to constructing and maintaining essential infrastructure, such as roads, bridges, and public transport systems. On the other hand, one of the most significant contributions is biomedical engineering and biotechnology, which are revolutionizing medicine and medical care contributing to the creation of advanced medical devices, gene therapies, and diagnostic systems. Another significant contribution is in computer engineering and telecommunications branches that have transformed how we communicate and access information, facilitating globalization and global connectivity. Engineering has also driven business innovation through product design, supply chain management, and process optimization.

Next, the cut meat goes through the washing process, where it is washed from side to side, and then continues to the quartering process, where cuts are made in the meat to divide it into quarter portions. Finally, it undergoes refrigeration while waiting to be distributed. Importantly, distribution must be done in refrigerated trucks to maintain meat quality. The meat is distributed to processing companies, which treat it to make sausages or other cuts. It is also distributed to specialized butchers that meet the needs of the business sector, restaurants, hotels, and finally to retail distributors, which can be stores or minimarkets that sell meat at retail. Next, the supply chain of the meat industry will be presented [8]:

C. Social responsibility and the university

The social responsibility of university students allows them to identify their commitment to the environment. The student has the challenge of committing himself personally and socially to the development of his community ethically and responsibly, seeking a country with better life opportunities for the entire population [5].

Concerning the challenges pursued by university social responsibility in future professionals is a long-term expectation; however, some challenges are prioritized and should serve as a guide for the student. First, the training of new researchers with the ability to identify the different problems within society; second, social participation, to strengthen the sense of democracy through the main mechanisms of public management by organizing themselves in guilds or associations that represent the true feelings of the population and, thirdly, professional performance with ethics, morals, and principles, the basis of every human being. These elements show that, by integrating research and social participation in professional practice, the person will be able to recognize their responsible commitment by making decisions in favor of the entire population. To achieve this goal, it is necessary to incorporate academic strategies that encourage social responsibility and motivate socially responsible behavior[8][9].

The research background indicates that few studies have focused on studying social responsibility in university students, comparing its socio-academic variables and the challenges for new professionals. Research has shown that men have shown more outstanding social commitment in some study groups than women [7]. Other studies[10] explain that university students in Peru have an average level of university social responsibility, indicating that they participate in the activities of commitment by obligation to pass certain subjects and not by conviction, and teachers must change strategies and mechanisms so that students can participate voluntarily. In addition, other research reveals that university students of engineering and social sciences are socially responsible students at a high level, [11] valuing aspects such as respect and collaboration between students and teachers, zero discrimination, comprehensive training, opportunity to participate in social projects and promotion of social sensitivity. However, in no case is it shown that there is a distinction between students of different careers. An essential characteristic in the samples analyzed in previous studies is that socially responsible students present positive attitudes such as empathy, tolerance, and respect for cultural values and the environment and are emotionally equitable with better social relationships [12][13].

These premises motivated me to formulate this work, which focused on the evaluation of social responsibility in engineering careers, as a focal axis because it is a career that concentrates historically on technical education and not on social aspects. To assess this work, a comparative analysis is made with students of social sciences jobs, who are traditionally more humanistic. Measuring the sense of social responsibility of university students includes the study of the commitment to others and the environment.

Students must understand their different realities and expand their capacities to serve others. In addition, the valuation of the personal discovery of values is one of the objectives of social responsibility to instill in students not only knowledge but also values of respect and recognition of the dignity of people. It also discusses the formation of social responsibility as the mechanism by which students transfer knowledge to society. Finally, the study of the approach of professional practice from social commitment is included, being one of the challenges of the social responsibility of the university to apply in practice the knowledge acquired in the professional field so that the student can continue to exercise and increase the ability to become a socially responsible person and committed to their environment[6][7].

III. METHODOLOGY

The research was descriptive-comparative, with a quantitative approach, using the non-experimental cross-sectional design [14]; data collected from May to July 2023 were considered. The sample was made up of 1023 university students from Peru. The participants who regularly attended classes were intentionally selected, took any subject that integrated university social responsibility activities, belonged to the areas of engineering and social sciences, and were students of any sex of all academic cycles. Only university students who did not wish to participate in the study were excluded.

The university social responsibility questionnaire (RSEU) validated by García and others [5]was applied. The test consists of 21 items, distributed in 4 dimensions, and a criterion item that the student must assess through the Likert scale that considers 1 to 5 points (1 = minimum agreement and 5 = maximum agreement). The instrument presents criteria of validity and reliability in its construct. The internal consistency indices to determine reliability were made through Cronbach's alpha coefficient, obtaining high scores (0.923). The construct validity through exploratory factor analysis indicates the existence of 3 factors that explain 56.45% of the variance. However, confirmatory factor analysis, with the maximum likelihood method, confirmed the reformulation of the initial structure of the scale to obtain a better measurement of the construct by pointing out the four dimensions and a criterion item. In addition, the reliability analysis of the scale was made to the local sample, using Cronbach's Alpha statistical test, obtaining an alpha of 0.88 considered high reliability [15].

The instrument was applied directly, individually, and face-to-face, considering the guidance García and others provided [5]. All procedures were carried out with due informed consent, committing to participate voluntarily by signing the respective document and with institutional rigors and permits.

The data were analyzed considering the normality distribution through the Kolmogorov-Smirnov test, finding that the data do not present a normal distribution ($p< 0.000$). Mean, skewness, kurtosis, and standard deviation were calculated. In addition, variance homogeneity tests were performed. Considering using nonparametric tests. The descriptive analysis of social responsibility in university students was carried out to determine the degree of social responsibility. In addition, the student's social responsibility was compared according to socio-academic variables such as sex, area, and cycle of studies. To reach the levels of social responsibility of the university according to socio-academic variables, contingency tables were used; in addition, the statistical test Chi-Square was used to determine the association of variables or check or reject the hypotheses of independence between the variables[16][17]. In addition, the JAMOVI 1.2.27 software was used to perform the statistical analysis [18].

IV. RESULTS

The analysis of the socio-academic variables presented by university students was made, finding the following information: 54% were men and 46% were women. According to the area of studies, 47.8% were students in the area of engineering and 52.2% in social sciences; in addition, the average age was 23 years with a standard deviation of 1.41 years in a range of 18 to 29 years, including to university students of all years and academic cycles. It was found that the level of social responsibility of the student and its dimensions is medium, with a tendency to be low (Table 1). The main difficulty students encounter is that there is no adequate training in social responsibility to apply it in society. Also, the student does not know many realities to commit to their environment, and the activities they perform as social responsibility are more helpful or social support.

Table 1. Level of Social Responsibility of the University and Dimensions of Study

MSW and dimensions	Level			*Total*
	High	*Middle*	*Low*	
Social responsibility of the university student	17%	56%	27%	100%
Commitment to others and the environment	23%	49%	28%	100%
Personal discovery of values	22%	60%	18%	100%
Social responsibility training	12%	57%	31%	100%
Approach to professional practice from social commitment	16%	51%	36%	100%

Regarding sex, it was obtained that men present, on average, a social responsibility of 42.2%, while women offer a social responsibility of 57.8%. Therefore, it was found that women tend to be more socially responsible, are more committed, discover their values, and consider their future professional practice from the social commitment concerning male students.

Table 2. Comparison of the social responsibility of the university and its dimensions of study according to area of study.

MSW and dimensions	Area of studies	
	Engineering	*Social sciences*
Social responsibility of the university student	40%	60%
Commitment to others and the environment	35%	65%
Personal discovery of values	45%	55%
Social responsibility training	37%	63%
Approach to professional practice from social commitment	41%	59%

When comparing the results according to the area of study of the university student, it was found that the students of social sciences develop more sense of social responsibility compared to the students of the engineering area—considering that the students of the different programs of social sciences by nature present more significant relationship and link with society, motivating the participation of these students in the other activities of Social Responsibility of the University.

From the comparison of the results according to the year of studies, it was found that students in the last years present a greater degree of social responsibility than the students of the first years of study, being the students of the previous years who, through their pre-professional practices find greater motivation to work responsibly for society.

Table 3 shows the results of the Chi-Square tests, which indicate that they are lower than the significance, rejecting the hypothesis of independence of the variables. In that sense, the socio-academic variables are significantly associated with the university's social responsibility. There is a high probability that to the extent that the university student studies a career in social sciences, is looking in the last years, and is a female student, the degree of social responsibility in the face of society's demands will increase.

Table 3. Chi-Square test between the social responsibility of the university and the socio-academic variables.

Chi-Square	*Test*	Area of studies	Year of studies	sex
Social responsibility of the university student	***p***	0.000	0.002	0.000
	Chi²	12,645^{to}	12,025^{to}	12,693^{to}
	Df	4	4	4

Note. p= p-value (0.05); Chi2= value of the statistic; Df= Degrees of freedom.

CONCLUSIONS

Once the study is completed, the following conclusions can be affirmed:

There is a significant social responsibility difference between engineering and social science students. Social science students tend to exhibit a higher social responsibility than their engineering counterparts. These findings highlight the importance of social science education for academic development and fostering greater awareness and engagement with social and community issues. It is necessary to include more significant activities of university social responsibility in the academic programs of the engineering area so that students can develop their social skills, improve social relationships, identify their values towards others, and think that engineering can solve various problems presented by communities and the environment.

Educational institutions could benefit from implementing awareness programs and developing social skills in engineering programs to promote greater social responsibility among students in this field. In this sense, interdisciplinary collaboration between engineering and social science students could effectively promote social responsibility in both groups, encouraging an exchange of perspectives and knowledge.

University students, in general, do not fully develop the competencies of university social responsibility due to the weakness in the content of the curricula, forcing the student to participate in social responsibility activities to pass the subjects and not because the competencies have been achieved within the training. Converting this professional value into fulfilling tasks and not acquiring social commitment as a person's value.

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There is confusion when executing university social responsibility activities because it is considered that most of these activities should benefit the population, bringing social assistance to the most precarious areas of society. In that sense, the academic challenge must pursue an end according to the identification and planning to help solve societal problems. In this way, the new professional must be clear about social commitment as part of his management in the area he performs.

This study opens the door to future research to analyze better the variables that influence social responsibility, such as educational curriculum, academic culture, and personal values, to understand the reasons behind the observed differences. Finally, it is crucial to highlight that social responsibility is a fundamental skill and attitude for professionals in all fields. The findings of this study have important implications for the preparation of future engineers and social science professionals who wish to address societal challenges and contribute to the well-being of society. It is necessary to continue doing studies related to university social responsibility to understand how this variable behaves, considering expanding the sample to more universities, allowing to compare the results of this study to take measures, especially in the academic system, to empower students and that their pre-professional practices are based on the common good ethically and effectively.

The challenges demanded by social responsibility in students are part of training new researchers who can identify societal problems. In this way, social participation is presented as an opportunity to strengthen the sense of democracy through the main mechanisms of public management organizing in guilds or associations that represent the true feelings of the population. It is essential to perform professionally with ethics, morals, and principles, the basis of every human being to integrate research and social participation in their professional practice for decision-making and promote new developments committed to social, animal, and environmental life.

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