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Factors Influencing the Choice of the Industrial Engineering Undergraduate Program

Danilo Leal (Professor)

Doctor in Statistics, Master in industrial engineering, Master in Management (minor in Finance) and Commercial Engineer, professional experience in evaluation projects and management control focused on budget control and provides several types of reports. Assistant Professor at the Faculty of Engineering and coordinator of the financial and economic track at Andrés Bello University, in Viña del Mar. Currently Director of Industrial Civil Engineering & Industrial Engineering. Excellent interpersonal relationships with a clear focus on achieving results.

Genaro Zavala (Professor)

Genaro Zavala is the leader of the Socially Oriented Interdisciplinary STEM Education Research Group of the Institute for the Future of Education at Tecnologico de Monterrey. He collaborates with the Faculty of Engineering, Universidad Andres Bello in Chile. He is National Researcher Level 2 in Mexico. His research lines are interdisciplinary STEM education, social oriented education, conceptual understanding, active learning, assessment tools, and faculty development. Dr. Zavala was appointed to the editorial board of the PRPER (2015-18). In the AAPT, he was a vice-presidential candidate, member of the Committee on Research in Physics Education, member and chair of the International Education Committee, and elected member of Leadership Organizing Physics Education Research Council.

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Abstract

Choosing a career is one of the most important decisions a person makes. The literature reports various investigations of the factors comprising students' career decisions, including educational and career aspirations, socioeconomic status, ability, parental encouragement, college attributes, and financial limitations. Some research suggests that these factors change during the school trajectory. Other studies state that the most critical factors are academic reputation followed by employment records. Literature also reports that parents, friends, guidance teachers, visiting recruiters, and school advisors most influence a person's institutional selection (in the presented order). Our ongoing research identifies the main factors influencing undergraduate industrial engineering choices at a multi-campus, private university in Chile. The university's industrial engineering discipline has two undergraduate programs, Civil Industrial Engineering and Industrial Engineering. Since we acknowledge that many factors may affect students' career choices and institutions, we sent a survey to determine the influence level of those factors on those students in the industrial engineering undergraduate programs at this university. Three hundred seventy-six industrial engineering students participated. Our findings were like other studies, which had differences among the program categories. From the results, we will focus our future work on what should be the program's admission strategies and how resources can be maximized. In addition, we will identify the primary factors for the university's other engineering undergraduate programs and then cluster them to create a profile of the prospective students.

Keywords: College Choice, Industrial Engineering, Undergraduate, Higher education, educational innovation, STEM education

I. Introduction

Today, one of the most critical decisions is the lifetime career choice, or at least an essential part. Given the above, students are influenced by different factors when choosing a program of study, and it does not necessarily have a direct relationship with their aptitudes. The student's decision to select a college goes through different stages, and various studies have attempted to model this process [1-5]. Moreover, universities worldwide try to attract as many students as possible to their programs, offering various benefits [6,7] and competing with other universities offering the same program [8,9].

Most studies aiming to understand the factors that influence students' decisions when choosing an academic program are conducted at the university level, either in graduate or undergraduate programs [3,10-13]. They customarily seek to understand the factors from a marketing perspective to use them for recruitment strategies [14-16].

Knowing the factors underlying a career choice allows one to focus the search for prospective students efficiently and optimize the utilization of resources to attain new enrollments. It is

possible to develop transversal strategies for all the university programs and customize them based on specific factors relevant to each career.

There are two programs related to industrial engineering in the university where this study took place: Civil Industrial Engineering and Industrial Engineering. The difference is that the former is a five-year program focusing more on decision-making, and the latter is a four-year program training students for industrial operations. The present study seeks to understand the main factors that drove students to choose the Civil Industrial Engineering and Industrial Engineering programs at this sizeable private university in Chile; the instrument was an adapted survey used in other studies [6,14].

The document is organized as follows: Section II describes the work related to the subject matter. Section III describes the materials and methods used. Section IV presents the results and discussion. Section V presents the study's conclusions and intended future work.

II. Related Work

This section presents the papers related to the central theme concerning the factors that influence the selection of a career. However, we should point out that we did not find specific research reports dealing with selecting particular disciplinary programs but rather selecting a university and its undergraduate or graduate programs.

There are three primary themes linked to students' choice of a university [11]. First, we find choice models that explain what influences them when choosing a university [17]. Second, are the investigations on the choice factors associated with students' university selections [3,18,19]. Third, some research examines young people's relevant information sources to explore university options during their selection process [20].

The students' decision-making process for a university consists of several stages, as we can see in [1,3-5]. One of the best-known studies is [2], which presents a three-stage behavioral model. In the first stage, called *predisposition*, the student develops an interest in attending college. In the second *search* stage, the student gathers information and pre-selects some universities. In the final *choice* stage, the students decide on particular institutions.

Another study [17] presents a model to identify the factors that affect the decision to enroll in a university and how they correlate with making a final decision. Some relevant factors are associated with the students' characteristics [4], others relate to the university itself, and others have to do with close relatives [14,10].

In Scotland, an exploratory study [12] of the factors that influence undergraduate students at six universities was conducted to determine whether a predictive model to estimate students' choices were possible. They identified three primary factors: academic reputation, distance from home, and location. They surveyed 650 first-year students in the accounting and engineering disciplines and performed a mean and factor analysis.

Another published work [14] studied the factors that influenced the choice of a university in which the approach was from a marketing point of view. Recommendations were that the institution should consider establishing its image or market position, identifying its competitors, determining the needs of different market segments, and developing a marketing plan to promote its service. This study is mainly based on the *Choice* stage described above [2] so that the university can promote itself in the identified segment. First, they researched market analysis, segmentation, and relevant factors to consider. Then they analyzed an institution from a marketing point of view.

The author in [14] found 27 studies with less than ten choice factors and 22 studies using ten or more. The studies were compared by ordering the different factors found and then using those with a higher frequency. The most repeated elements were academic reputation, location, quality of teaching, availability of programs, quality of faculty, costs, program repute, financial aid, and employment outcomes. These were followed by the variety of courses offered, size of the institution, the nearby community, availability of graduate programs, employment opportunities for students, quality of social life, class size, graduate school outcomes, extracurricular programs, friendly/personal service, affiliation, admission requirements, and attractiveness of campus facilities.

After gaining clarity regarding the factors influencing students' decisions, the authors [14] modified the current survey conducted at Utah Valley State College (UVSC). They took all 2001 Utah high school graduates with UVSC as an entrance preference. They performed descriptive and ANOVA analyses. The top ten factors identified for UVSV students were the ability to live at home or commute, ability to work while studying, availability of their major/program of study, cost of tuition, previous credits awarded at the school, variety of course schedules (e.g., evening, weekend, internet), quality of the program in their major, scholarship availability, safety, and small class size. Another relevant result corresponded to the information sources students consulted when choosing a university: web pages, campus visits, university catalogs or schedules, personal contacts, and university guides.

One study addressed the factors influencing an engineering career choice [21] by surveying engineering students and graduates, thinking not about a particular university or specific engineering program but the prospects of their labor field. The survey contained 44 factors rated on a five-point scale. Responses were provided for several subgroups to demonstrate differences in gender, ethnicity, and engineering career field, tested using a chi-square analysis.

Among the main results, the most influential factors related to work were challenges, creativity, independence, problem-solving, and salary. When choosing an engineering career, graduates were more likely than students to cite related work experiences, and students were more likely to mention security and speed of advancement. Differences were observed in comparisons by gender, ethnicity, and engineering field. Women and minorities valued independence, challenges, female role models, and pre-college programs more than men.

Kallio [10] analyzed the relative influence of factors affecting graduate students' choice of universities. The study was based on a survey of students in master's and doctoral programs at the University of Michigan. They aimed to identify which factors were associated with age, then

identify factors related to enrolling or not enrolling in Michigan. Finally, an analysis determined the main dimensions in the final enrollment decision.

Some findings were that students under 30 were more geographically mobile and considered a more comprehensive range of institutions. They also tended to give more importance than older students to the social aspects of university life and were more likely to be undecided about their specific career plans. In contrast, older students placed more importance on spousal and work-related considerations. They were more likely to pursue graduate studies to advance their already committed career.

From the analyses, we concluded that the most predominant factors are state of residence, characteristics of the institution's academic environment and its programs, work-related concerns, spousal considerations, financial aid, and the social environment of campus life.

III. Materials and Methods

A 21-item survey was designed based on [6,14], adapting the questions to identify the relevant factors when selecting the Civil Industrial Engineering or Industrial Engineering programs. After the first adaptation, the survey was validated by five academic experts in engineering education and students from the same program. After the survey validation, the authors identified the population of students (5,176) at the university and obtained a sample with a 95% confidence interval and 5% error, resulting in 358. It was decided to send the survey by e-mail to all Civil Industrial Engineering & Industrial Engineering students.

The survey first had some consent data, career identification, year of entry, and study day. Then, there were Likert-type questions with a scale of 1 to 5 (1 = Not at all important, 2 = Not so important, 3 = Neutral, 4 = Important, 5 = Very important). Finally, open questions captured information not obtained in the closed questions. The questions were grouped into five dimensions:

- **Parents and friends**. Items related to the influence of family and friends in selecting what to study.
- **Labor market**. Items related to the employability of the career and its possible remuneration.
- **Career-specific**. Items related to the program's characteristics.
- **University-specific**. Items corresponding to the university's reputation and its faculty members and the characteristics of university program delivery.
- **Others**. Other items containing factors identified in the literature.

The survey can be reviewed at the following link: https://forms.office.com/r/Ctv7JSETKK

IV. Results and Discussion

This section presents the overall results and discussion of the investigation. The first subsection with descriptive results is followed by the subsections covering overall results for all students and the findings for each specific program. The last subsection presents the results for each dimension.

Descriptive and overall results

Three hundred seventy-six students responded to the survey, with 18 more answers than the calculated sample. Table 1 shows that 54% of the respondents were in the Civil Industrial Engineering program, and the remaining 46% were in the Industrial Engineering program.

Table 1. Distribution by the program in which students were registered.

	Program
Civil Industrial Engineering	203
Industrial Engineering	173
Total	**376**

The following three Figures present the overall results of the survey. Figure 1 shows the students' mean for each survey item. The scale for each item goes from one to five with a theoretical mean of three. There are 13 items with a result higher than the theoretical mean (neutral on the Likert scale) and eight with a result less than the theoretical mean.

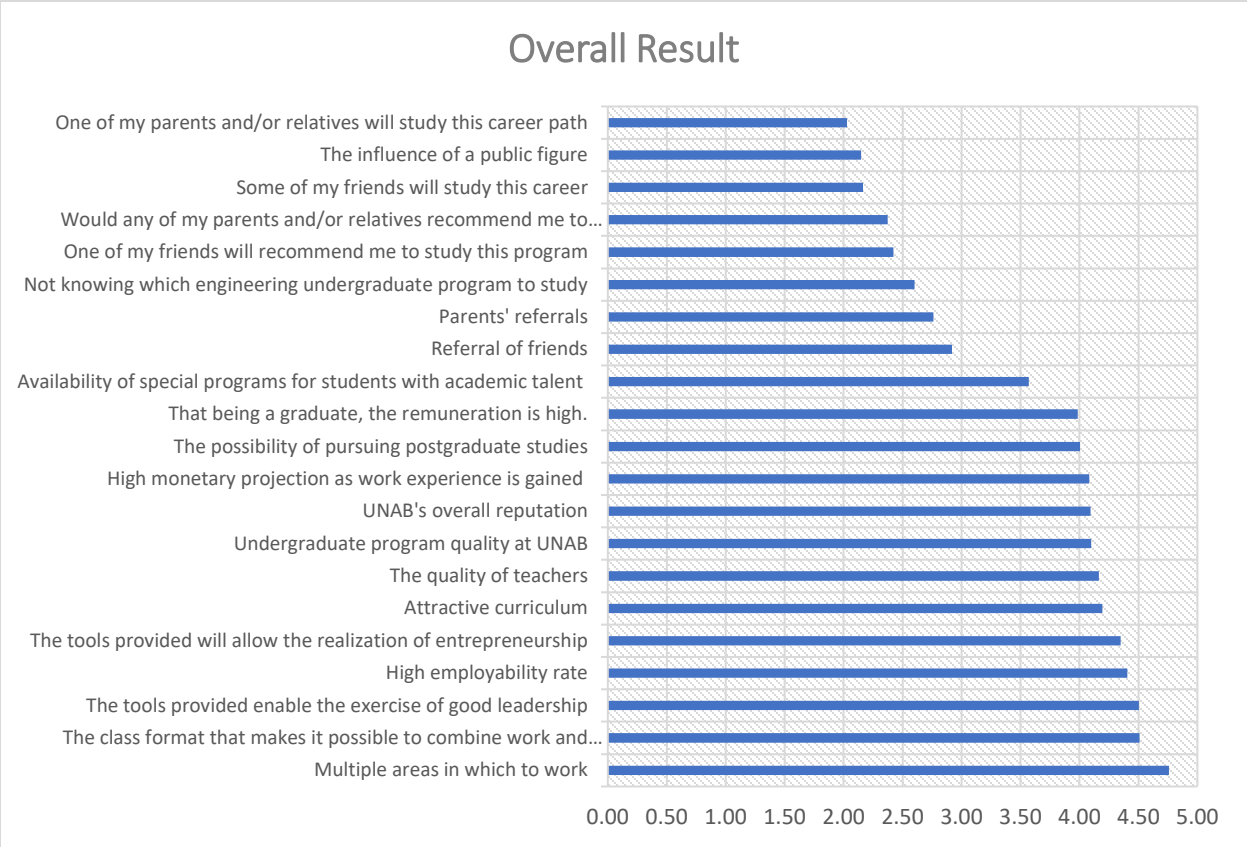

Figure 1. Overall results.

The top five factors were: *Multiple areas in which to work*, *the class format that makes it possible to combine work and study*, *the provided tools that enabled the exercise of good leadership*, *a high employability rate*, and *the tools offered facilitated entrepreneurship*. The bottom five factors were: *One of my parents or relatives study this career path*, *the influence of a public figure*, *some*

friends study this career, *my parents or relatives recommend this career*, and *one of my friends recommend that I study this program*.

The results indicated that *labor market* items and *career-specific* dimensions were the most influential. On the other hand, four out of five factors students considered less critical were in the *parents and friends* dimension. It seems that industrial engineering students from both programs were more influenced by their academic offerings. These results are essential for program coordinators and the university programs' attraction offices.

Figures 2 and 3 present the results separated by the program. For Civil Industrial Engineering, the same top factors were maintained; however, the order changed (see Figure 2). The same happened with the five bottom factors; they are the same but in different order.

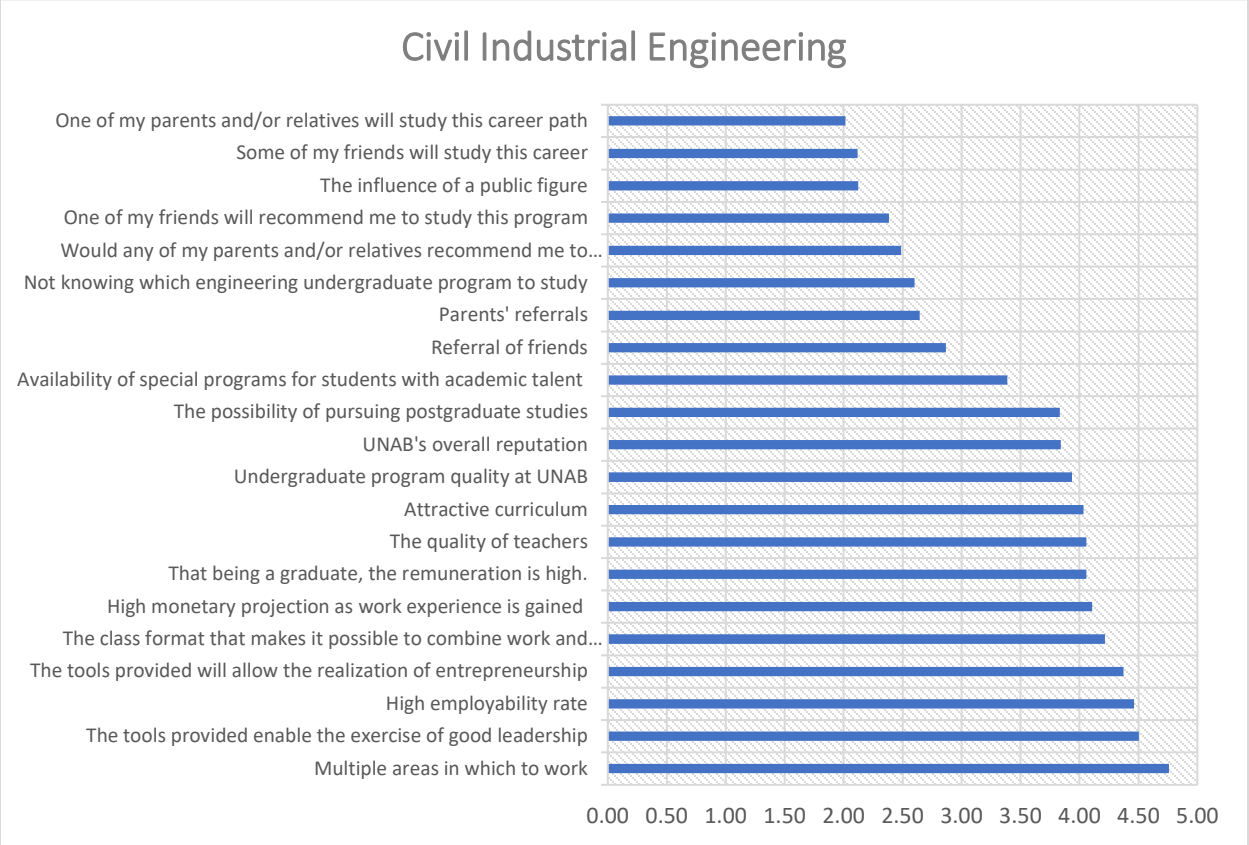

Figure 2. Civil Industrial Engineering result.

In the case of Industrial Engineering, two factors that had not been considered among the top five most important (see Figure 3) were *the overall reputation of the university* and *the engaging curriculum*. The two items not in the top five were a *high employability rate* and *the provided tools facilitate entrepreneurship*. In the case of the bottom five, the factors were the same as the overall results shown in Figure 1.

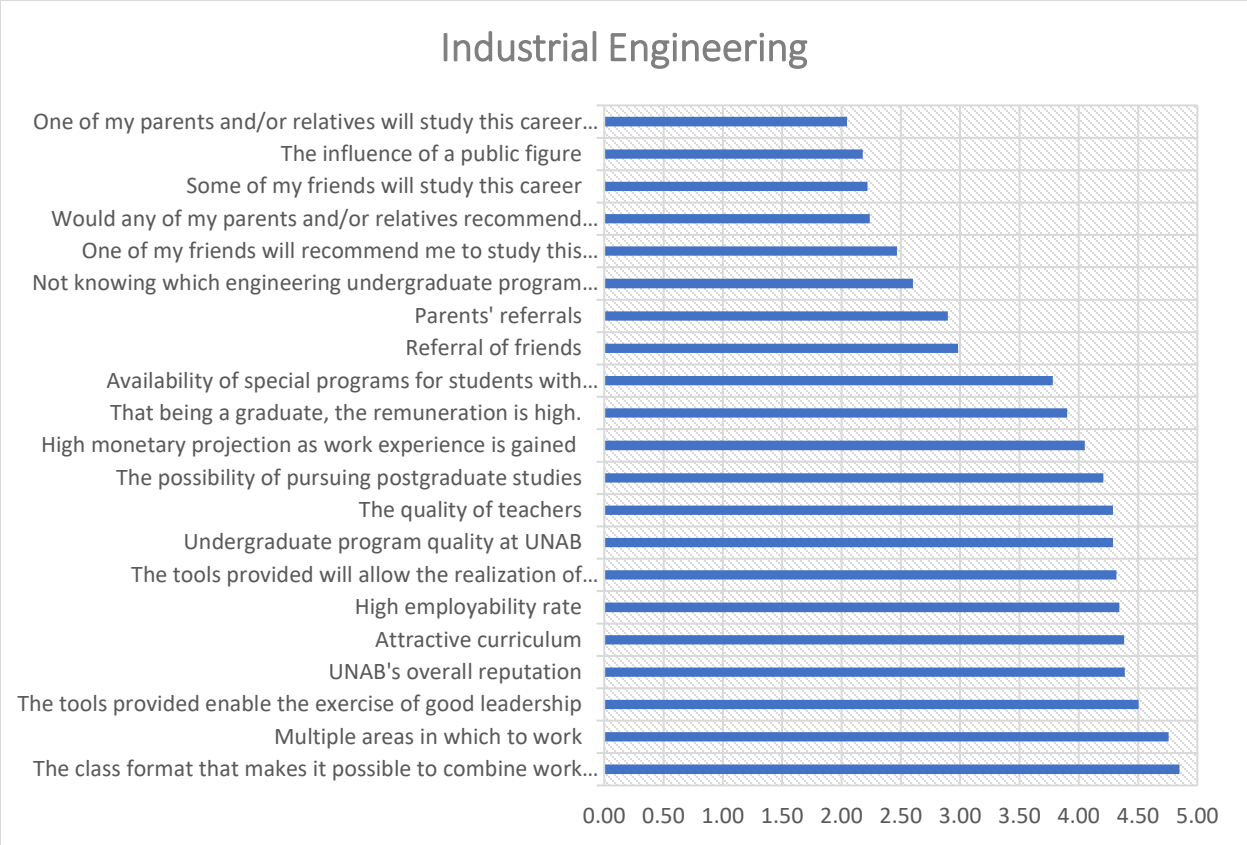

Figure 3. Industrial Engineering result.

The differences in the most influential factors by program are essential information for the attraction office. The program can slightly differentiate the attraction campaign. In the case of Civil Industrial Engineering, the marketing to attract students could emphasize the labor market dimension. In the case of Industrial Engineering, the emphasis on the university's reputation could prove impactful.

Results by dimension

Next, we show the dimensions analyses to identify the students' preferences (Figures 4 to 7). We graphed the Likert-scale results in those figures, combining the Likert-scale percentages of *important* and *very important* values for the vertical scale. We also combined the percentages for *not at all important* and *not so important* to be values for the horizontal scale. The data points interpret the Figures. Suppose the data point is the (60%, 30%) coordinate. It means that 60% (horizontal axis) of the students answered either *not at all important* or *not so important* to that item, 30% (vertical axis) of the students answered either *important* or *very important* values to that item, and the rest (10%) had neutral responses. This approach allows an overview of the main factors of the respondents. In the figures, the labels are codes for each factor and program. In the case of dimensions, PF is *Parents and Friends*; LM is *Labor Market*; CS is *Career-specific*; US is *University-specific*. In the labels, the letter C at the beginning represents the Civil Industrial Engineering program and the letter I the Industrial Engineering program.

Parents and friends

Figure 4 presents the results of the *Parents and friends* dimension. The specific items are:

1. One of my parents and/or relatives study this career path.
2. Some of my friends study this career.
3. Some of my parents and/or relatives recommend that I study this career.
4. One of my friends recommends that I study this program.

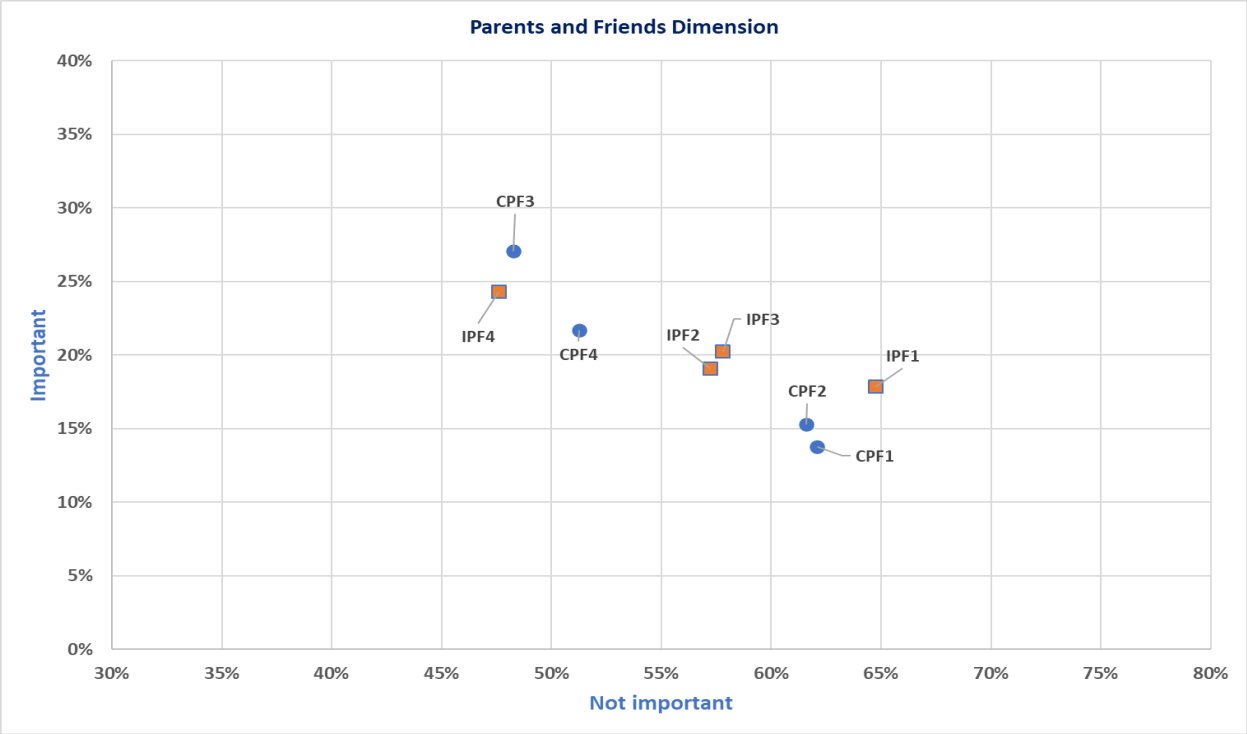

Figure 4. Parents and Friends result. PF = Parents and Friends. The orange square and the C at the label's beginning are for the Civil Industrial Engineering program. The blue circle and the I at the label's beginning are for the Industrial Engineering program.

As shown in Figure 4, there are no differences in any particular factor. For both Civil Industrial Engineering and Industrial Engineering, the parents or friends studying the career are not important. Neither are the recommendations of parents and friends. All items in this dimension are in the lower part of the *important axis* and the higher part of the *not important axis*.

Figure 4 is noteworthy because items 1 and 2 for both programs fall in the right part of the graph and items 3 and 4 in the left. It infers that parents and friends studying that program is less important than the recommendations students receive from parents and friends. Students in both industrial engineering programs are not influenced much by what close persons have studied.

Labor market

Figure 5 presents the results of the *Labor market* dimension. The specific items are:

1. The remuneration is high for graduates.
2. High monetary projection as work experience is gained.
3. High employability rates.
4. Multiple areas in which to work.

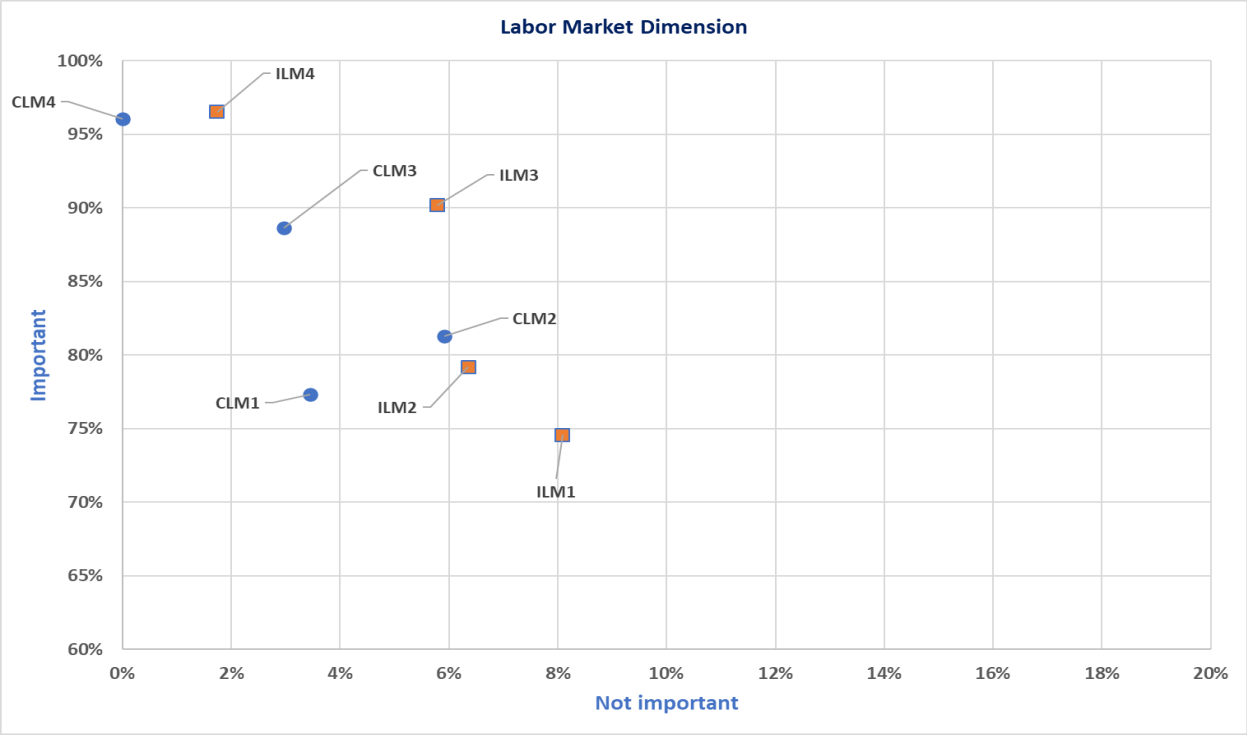

Figure 5. Labor market result. LM = Labor Market. The orange square and the C at the label's beginning indicate the Civil Industrial Engineering program. The blue circle and the I at the label's beginning are indicators for the Industrial Engineering program.

Opposite to the results in the *parents and friends* dimension, all items were important factors for choosing the program in the *labor market* dimension. In this dimension, the results ranged from 75 to100% as important and 0 to 8% as not important.

The following results are notable:

- For both Civil Industrial Engineering and Industrial Engineering, the expectation of excellent remuneration is high (item 1). 75% of those surveyed for each career indicated either "important" or "very important."
- For both Civil Industrial Engineering and Industrial Engineering, the expectation of monetary increases with advancing experience is high (item 2). 80% of those surveyed by career responded either "important" or "very important."
- For both Civil Industrial Engineering and Industrial Engineering, the expectation of a high employability rate (item 3) is much more relevant than a high remuneration or monetary projection as 90% of those surveyed by career indicated either "important" or "very important."
- For both Civil Industrial Engineering and Industrial Engineering, the expectation of having multiple areas to work (item 4) is much more relevant than a high remuneration, monetary projection, or employability rate, as 95% of those surveyed by career indicated either "important" or "very important."

In summary, there was a high expectation of students in the *labor market* dimension. 75% expect high pay, 80% expect monetary increases with advancement, 90% expect a high employability rate, and 95% anticipate multiple performance areas in which to work. The results of this dimension can be used in the programs' attraction plans.

Career-specific

Figure 6 presents the results of the *Career-specific* dimension. The specific items are:

1. The provided tools enabled the exercise of good leadership.
2. The provided tools facilitate entrepreneurship.
3. Attractive curriculum.

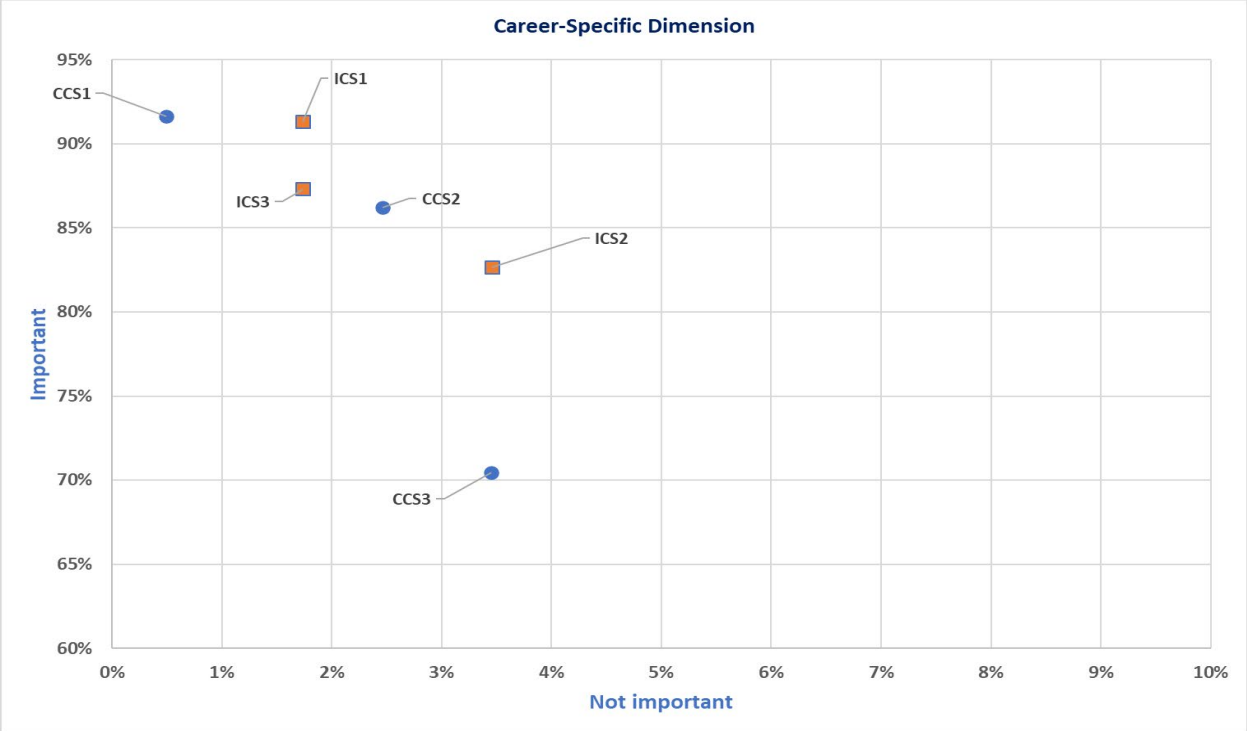

Figure 6. Career-specific result. CS = Career-specific. The orange square and the C at the label's beginning indicate the Civil Industrial Engineering program. The blue circle and the I at the label's beginning are indicators for the Industrial Engineering program.

For the case of the *career-specific* dimension, the main results are:

- For respondents in both programs, providing leadership tools is highly important, as nearly 91% indicated this in each career.
- Compared to tools for leadership, entrepreneurship tools are less important but still very high overall, as, in both careers, 85% indicated "important" or "very important."
- In Industrial Engineering, 87% of students' responses indicated the importance of the item related to the curriculum's attractiveness. For Civil Industrial Engineering, this decreased; there were 26% neutral responses.

The most significant difference between the programs is item 3, an attractive curriculum. Students in the Industrial Engineering program valued more the attractiveness of their program than students

in the Civil Industrial Engineering program. This result could be due to different strategies for attracting high school students to these two programs.

University-specific

Figure 7 presents the results of the *University-specific* dimension. The specific items are:

1. University's overall reputation.
2. Undergraduate program quality at the university.
3. The quality of teachers.
4. Referral of friends.
5. Referral of parents.
6. Availability of special programs for students with academic talent.
7. The possibility of pursuing postgraduate studies.
8. The class format that makes it possible to combine work and study.

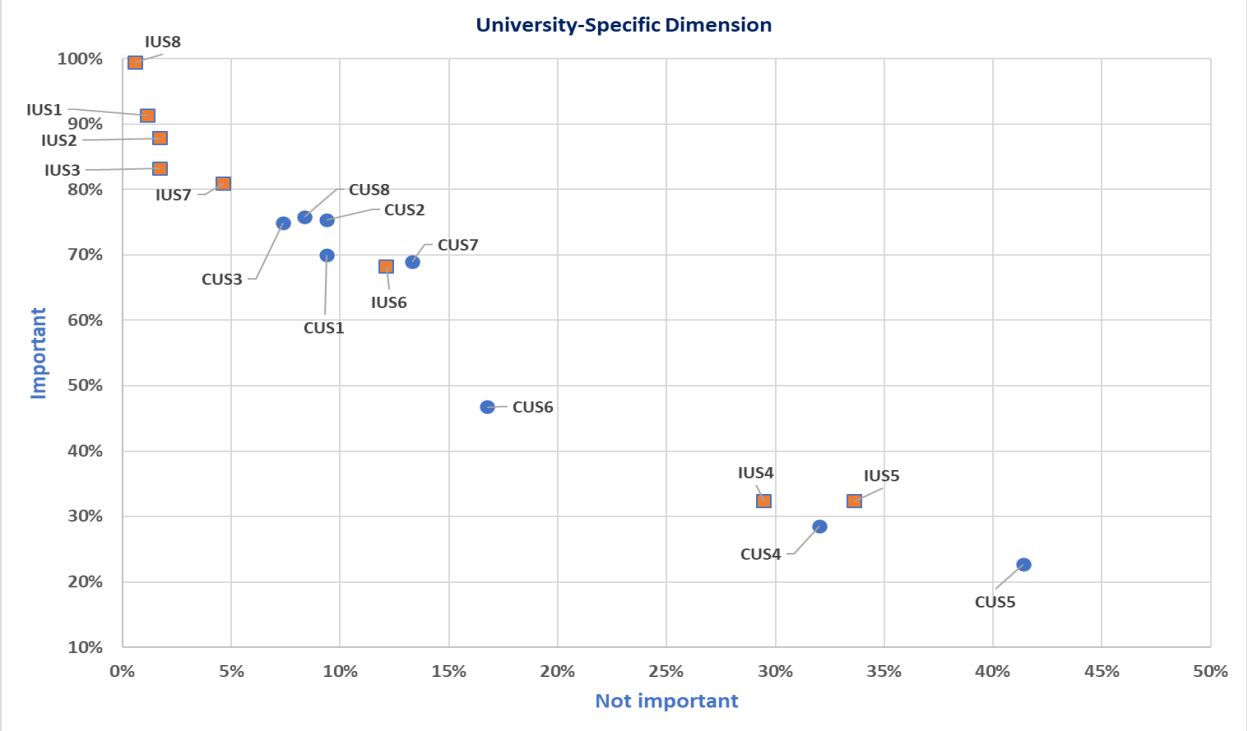

Figure 7. University-specific result. US = University-specific. The orange square and the C at the label's beginning indicate the Civil Industrial Engineering program. The blue circle and the I at the label's beginning are indicators for the Industrial Engineering program.

For the case of the *University-specific* dimension, the main results are:

- In general, Industrial Engineering students value all items better than Civil Industrial Engineering students. All items in the Industrial Engineering program (orange squares) are to the left and above the corresponding items in the Civil Industrial Engineering program (blue circles).
- Items 1, 2, 3, and 8 are the most important factors for students in both programs.
- Students value items 4 and 5 less, which have to do with parents and friends.

- Having special programs (item 6) is more critical for Industrial Engineering students than for Civil Industrial Engineering students. The difference is that many students in Civil Industrial Engineering answered this item as neutral.
- The importance of pursuing a postgraduate degree (item 7) is higher in Industrial Engineering students than in Civil Industrial Engineering (10% higher).

The general reputation, the reputation of the program, and the repute of the faculty members comprise the university's good reputation. Student results indicated that they are essential factors in choosing to study at that university, and industrial Engineering students valued those items more. This result may suggest that although it is also important for Civil Industrial Engineering students, attraction strategies could differ between the programs.

It is much more critical for Industrial Engineering students to have class formats that make work and study compatible. 86% of Industrial Engineering students indicated "very important" compared to 58% for Civil Industrial Engineering students. Since the duration of the program is different, the students' characteristics should also differ. Students in the Industrial Engineering program could have more intention to work while studying than students in the Civil Industrial Engineering program.

The references of parents and friends to study at the university are the minor influential factors for students in both programs. In the case of friends' referrals, almost 40% of students answered neutrally. These results align with the results of the *parents and friends* dimension. According to the university registration, most students in this university are first-generation university students, which might explain these results.

Others
The items of this dimension are:

1. Not knowing which engineering undergraduate program to study.
2. The influence of a public figure.

There is no figure for this dimension since it has only two items. In summary, there were divided responses, but the majority indicated not attaching importance to the influence of public figures or not knowing which engineering discipline to study. For both programs, about 70% of respondents downplayed the elements of this section. The trend in both programs was "not at all important," with about 47% in both. However, it is notable that 14% of Civil Industrial Engineering students and 16% of Industrial Engineering students had preferences of "very important" or "important."

V. Conclusions and future work

One of the most important decisions to be made when graduating from high school is the university and the undergraduate program that will determine where a student will work. Most of the studies we analyzed attempted to understand the factors that influence choosing a particular university but did not address the factors that influence the decision to study a specific undergraduate program. In this study, the objective was to understand the determining factors for studying Civil Industrial Engineering and Industrial Engineering in a private university in Chile using a survey adapted from ones that had already been validated.

Knowing the students' determining factors in choosing a program of study is very important for different departments of a university. First, the Admissions office must know what is important to the future entering students. This knowledge allows focusing on resources to generate effective marketing campaigns and increase enrollment in their programs. As seen in the literature, generic surveys for the entire university do not facilitate optimizing marketing resources nor provide relevant program information. Secondly, targeted information for each program allows for adjustments to be made to the curriculum to keep current.

The main student choice factors for the industrial engineering programs at this university are related to the labor market and career-specific items. In particular, the flexibility of areas in which students can work and the high employability rate are predominant. Also significant are the undergraduate program characteristics, such as the emphasis on leadership and entrepreneurship. There are specific differences in the top factors in each program that student attraction offices should consider to modify their attraction strategies in those programs.

The minor influential factors were related to the parents' and friends' dimensions. Moreover, in the university-specific dimension, the items related to the recommendations of parents and friends were the least influential. These results make stronger the advice to put efforts into the communication of the program to students.

With these results, we could adapt our class formats to blended modalities and continue to advance the program's positioning in national and international rankings. We could also develop a more effective communication plan with program applicants, highlighting the main factors currently considered.

The results of this study may differ from results in other universities because the student characteristics might vary. For instance, as previously stated, most of our students are first-generation university students. However, the survey is suitable to measure the factors in other educational environments.

Future work will be related to identifying more characteristic variables of the applicants to focus on the communication plan. The study will be extended to other programs in the School of Engineering and determine if the entrance profiles are different.

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