

# Labor Supply and Analysis of the Impact of Covid-19 on Engineering Programs

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## Abstract

This article presents the impact generated by the Covid-19 in the undergraduate offer of three engineering careers: Civil, Mechanical and Systems, taking into account the effect on Higher Education by the system of alternation which has limited access to different programs. The analysis of the Systems Engineering program is highlighted because it has become one of the programs with the greatest labor supply, due to the needs that imply the putting on line of diverse processes in all business and academic areas requesting professionals in computer science. Due to the above, the analysis of the demand in the offer in the Catatumbo region is presented, taking as reference the academic periods both in the pandemic and before it in the years 2019 to 2021, analyzing six academic semesters. The statistical data used are pre-enrollment and enrollment, making a correlation with other programs taught at the university. The results show that the academic offer remains constant at the time of Covid-19, placing the Systems Engineering program as one of the most requested programs at present, but without showing an increase in applicants as a result of the increase in the labor supply of professionals in computer science.

**Keywords:** Academic offerings; systems engineering; Covid-19; Higher education, Mechanical engineering.

## I. INTRODUCTION

The Covid-19 has been affecting the general population and its consequences in the academic field has brought countless changes such as: preventive isolation, students with virtual classes and putting online administrative systems for the normal development of student applications. In Colombia, a vaccination process is being implemented to allow teachers and students to return to the university in person [1]. The process was designed in two phases, where the first phase has three stages, stage one applies a vaccination to health professionals, population aged 80 years or older. Stage 2 to the population between 69 and 79 years and stage 3 to teachers, managers and administrative staff of educational institutions, with which teachers and administrative staff of universities complete their vaccination schedule. For students over the age of 16 years is in phase 2 and stage 5, which is already being applied, however they remain in their homes receiving virtual classes taught by teachers from their respective universities. By mid-October, the total number of doses applied was more than 40 million and more than 19 million with complete vaccines [2].

In Colombia due to the pandemic companies had to change their processes and migrate to IT solutions, 6 out of 10 companies had a digital transformation [3], [4]. In countries close to Colombia, e-commerce also became essential for MSMEs such as Ecuador [5], [6]. When making comparisons with countries in the region where Brazil, Chile and Argentina had greater infrastructure and e-commerce, the pandemic has resulted in an opportunity for the Andean region [7], in addition to applying digital marketing [8], to continue with their sales processes. A study conducted in Mexico can give a global idea of the situation of companies to make their change of business model where they analyze the problems of business closures and how they have continued to operate, which has brought economic losses and unemployment [9].

From the educational field, universities should accelerate their technological transformation to offer virtual classes with all the necessary platforms to provide online solutions. Not all institutions were prepared to face the closure, and the impact was very large due to inequality worldwide, within the problems of connection and access to documentary information for classes, students report little training of teachers for this type of distance education [10]. The methodology had to change to adapt to the pandemic, each subject brought complex challenges, where the evaluations were at the end a very important task to understand if the procedures included in each subject were working and, not having guides beforehand to face the pandemic, teaching-learning processes were adapted, which are measurable after each experience to correct and strengthen each methodology [11]. Different tools were created that were inclusive, allowing students with disabilities to stay connected with the classes [12]. In addition, the incidence of Covid-19 in the education of areas in Colombia, such as Catatumbo, was reviewed [13].

With the Covid-19 the labor supply brings new opportunities for some professional areas, it is the case of the systems career and the high demand by companies, individuals and public institutions in Latin America, placing within the 10 professions with more demand first the Web Developer "front-end and back-end", then the Data Engineer, also the Director or coordinator of e-commerce, Generator of digital content, areas directly related to Systems Engineering [14]. Colombia does not escape from the high demand for this type of professionals, with a deficit of more than 80 thousand employees by 2020 [15], [16]. The report "The Future of Jobs 2020" highlights the difficult situation that companies have to keep this type of employees on their payrolls [17]. But the high demand is not in

accordance with the number of students currently enrolled in the university, as in the case of the city of Medellin, who have determined that the curriculum should be changed, reaching the year 2021 with a demand for 100,000 systems engineers, without finding who can fill these positions [18]. But the question is whether it is only the curriculum that needs to be changed or whether it is the salary that this type of professional receives, with an average of 800 dollars [19].

With the above it should be determined if the low demand to study systems, is happening in some regions or is something common throughout Colombia, and taking into account the huge labor supply that has brought the Covid-19 for this type of professionals, it should be analyzed if they have achieved increase in applicants to enter universities, that is why in this research refers to engineering careers in the department of Norte de Santander, focused on the Catatumbo (UFPSO), in order to know the demand before and during the Covid-19, especially the Systems Engineering program.

## II. METHODOLOGY

We have analyzed 3 semesters before Covid 2019-1, 2019-2 and 2020-1, the variables have included pre-enrollment with or without purchase of a PIN for registration and, they have been compared with 3 semesters during Covid-19 2020-2, 2021-1 and 2021-2. Although the results of 12 academic programs are shown, the Faculty of Engineering stands out with 3 programs: Civil Engineering, Mechanical Engineering and Systems Engineering.

Due to the pandemic, the labor supply has increased for professionals with knowledge in Computer Science that is why an analysis of the entry and intention of study of new applicants in the career of Systems Engineering is made.

Within the variables analyzed, the academic program, semester, year, if it has a PIN, and the general total of each program are taken into account; the origin is not taken into account. The semesters affected by COVID are carried out virtually through the Moodle and Meet platforms.

The general totals of the first 3 semesters are taken and the percentages of increase or decrease of the engineering careers are analyzed. Without taking into account the socio-economic variables, only the statistical data of the Admissions office, which can determine whether after an increase in the labor supply of Systems has served to increase the number of applicants in the UFPSO who wish to study systems engineering. The above will allow institutions to find causes, consequences and renew their academic offerings.

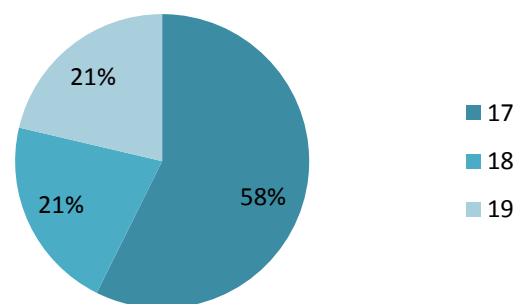
## III. RESULTS

The results comprise 6 semesters of the last 3 years, which comprise the number of pre-enrolled students, before and during the Covid-19 pandemic. In Table 1, the overall total of pre-registrants with PIN (Y) or without PIN (N) for the first semester of 2019 can be observed. The 3 careers of the faculty of engineering with code 17, 18 and 19 are analyzed, which belong to Civil, Mechanical and Systems.

**Table 1.** Pre-enrolled 2019-1

| CODE        | N   | S    | Grand total |
|-------------|-----|------|-------------|
| 16          | 62  | 106  | 168         |
| 17          | 129 | 248  | 377         |
| 18          | 48  | 100  | 148         |
| 19          | 48  | 148  | 196         |
| 22          | 60  | 115  | 175         |
| 23          | 37  | 51   | 88          |
| 24          | 116 | 247  | 363         |
| 25          | 63  | 103  | 166         |
| 31          | 74  | 112  | 186         |
| 71          | 52  | 72   | 124         |
| 94          | 30  | 28   | 58          |
| 95          | 95  | 169  | 264         |
| Grand total | 814 | 1499 | 2313        |

In Figure 1, it can be determined that the percentage of applicants who do not continue with the process is higher in the civil engineering career. And in the Systems career, 79% of students continue with the admission process.



**Fig. 1.** Percentage of applicants who did not continue with the process in Civil, Mechanical and Systems.

For the second semester of 2019, pre-enrollment has a decrease of applicants due to the fact that the year ends in December and in the first semester more applicants wish to continue their education, so that in the second semester the pre-enrollment rate drops due to the admission of students from the previous semester (Table 2).

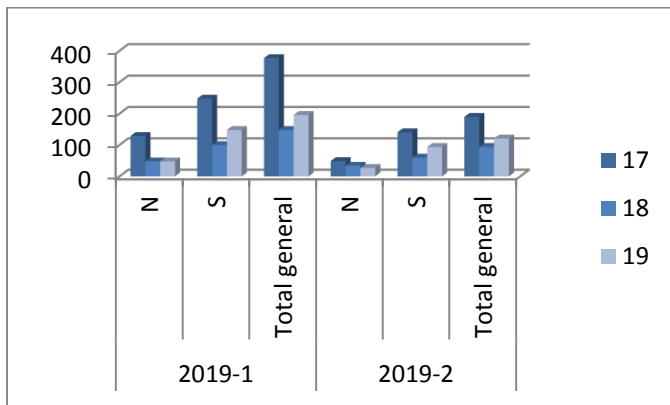
**Table 2.** Pre-enrolled 2019-2

| CODE        | N   | S    | Grand total |
|-------------|-----|------|-------------|
| 16          | 39  | 88   | 127         |
| 17          | 49  | 141  | 190         |
| 18          | 34  | 60   | 94          |
| 19          | 27  | 94   | 121         |
| 22          | 47  | 78   | 125         |
| 23          | 17  | 36   | 53          |
| 24          | 54  | 181  | 235         |
| 25          | 42  | 101  | 143         |
| 31          | 17  | 82   | 99          |
| 71          | 20  | 46   | 66          |
| 94          | 24  | 44   | 68          |
| 95          | 48  | 93   | 141         |
| Grand total | 418 | 1044 | 1462        |

**Table 3.** 2020-1 Pre-enrollees

| CODE        | N   | S    | Grand total |
|-------------|-----|------|-------------|
| 16          | 45  | 120  | 165         |
| 17          | 101 | 242  | 343         |
| 18          | 30  | 110  | 140         |
| 19          | 38  | 141  | 179         |
| 22          | 25  | 95   | 120         |
| 23          | 35  | 76   | 111         |
| 24          | 115 | 260  | 375         |
| 25          | 16  | 42   | 58          |
| 31          | 58  | 142  | 200         |
| 71          | 37  | 76   | 113         |
| 94          | 21  | 49   | 70          |
| 95          | 61  | 138  | 199         |
| Grand total | 582 | 1491 | 2073        |

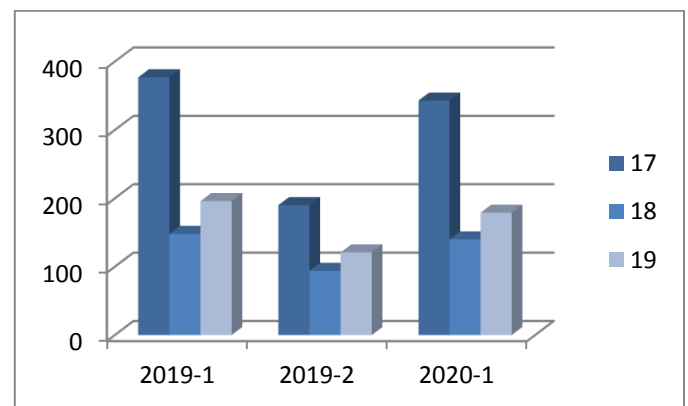
In Figure 2, the Civil program has decreased the number of students who did not want to continue with the process, while in Systems the number of students who did not want to continue with the process has increased by 4%.



**Fig. 2.** Grand total 2019 engineering programs.

For the first semester of 2020 applicants pre-registered at the end of December 2019 and, the pandemic began to take effect in March 2020 so the data did not affect the number of applicants. In 2020-1 the number of applicants is expected to increase as it coincides with the completion of the last year of high school (Table 3).

In Figure 3, it can be observed that for the period 2020-1, before the pandemic, the number of students with respect to previous semesters has decreased slightly. The Systems Engineering program maintains a value similar to the two previous periods for the variable of continuing with the process of entering the program. While Civil Engineering maintains 60%, a fairly high value, which may be affected by socio-economic problems or admission to other universities.

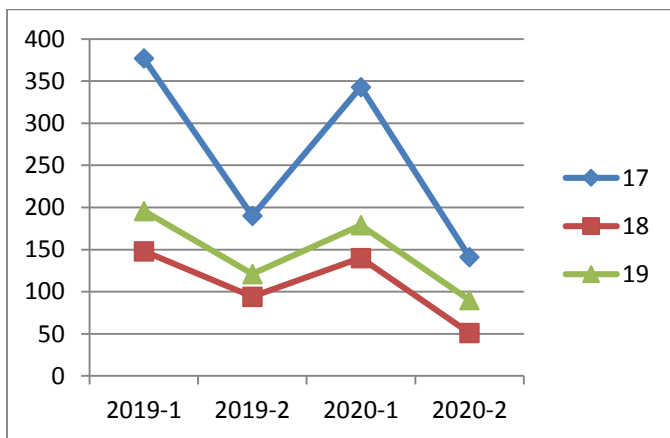


**Fig. 3.** Total number of pre-enrolled students in semesters prior to Covid-19.

The data from the second semester of 2020 reflect the effects of the pandemic, where work related to computer science begins to strengthen, however, it is not yet possible to make a real analysis in such a short time, but a decrease in the pre-enrollment of students in all programs can be observed (Table 4). In Figure 4 it can be determined that the period 2020-2 becomes the semester with the least number of pre-enrolled applicants.

**Table 4.** 2020-2 Pre-enrolled

| CODE        | N   | S   | Grand total |
|-------------|-----|-----|-------------|
| 16          | 13  | 52  | 65          |
| 17          | 42  | 99  | 141         |
| 18          | 12  | 39  | 51          |
| 19          | 24  | 66  | 90          |
| 22          | 17  | 33  | 50          |
| 23          | 15  | 19  | 34          |
| 24          | 45  | 120 | 165         |
| 25          | 35  | 89  | 124         |
| 31          | 18  | 64  | 82          |
| 71          | 13  | 42  | 55          |
| 94          | 3   | 37  | 40          |
| 95          | 20  | 73  | 93          |
| Grand total | 257 | 733 | 990         |



**Fig. 4.** Relationship of pre-enrolled students with the first semester of starting Covid-19.

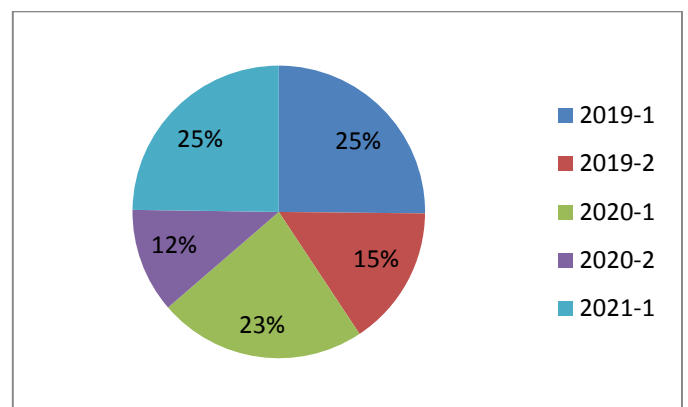
For the period 2021-1 almost a year with the effects of the pandemic and after implementing all subjects of the programs with digital platforms, in addition to the requirements of private companies for expert personnel in computer science the results

of specific supply for the Systems Engineering program (Table 5).

**Table 5.** Pre-enrollees 2021-1

| CODE        | N   | S    | Grand total |
|-------------|-----|------|-------------|
| 16          | 50  | 103  | 153         |
| 17          | 117 | 264  | 381         |
| 18          | 30  | 74   | 104         |
| 19          | 48  | 145  | 193         |
| 22          | 53  | 92   | 145         |
| 23          | 30  | 38   | 68          |
| 24          | 158 | 238  | 396         |
| 25          | 62  | 101  | 163         |
| 31          | 53  | 104  | 157         |
| 71          | 33  | 67   | 100         |
| 94          | 25  | 28   | 53          |
| 95          | 68  | 148  | 216         |
| Grand total | 727 | 1402 | 2129        |

In Figure 5, it can be determined that the periods of 2019-1 before the pandemic and 2020-1 after the pandemic have pre-enrollment results equal to 25%, with which it can be affirmed that the program has not had consequences in its academic offer, while in Civil and Mechanical there is a decrease in pre-enrolled applicants.



**Fig. 5.** Total percentage of students in Systems in relation to the period 2019-1 and 2021-1.

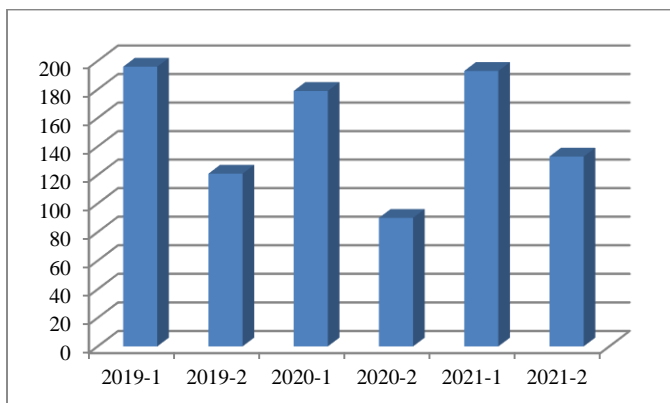
For the period 2021-2, after stabilizing all academic processes to cope with the pandemic, in addition to having to live with this problem on the part of the population, it can be deduced

that there is no significant increase or decrease for engineering programs when compared to the second semester of 2019 before the pandemic (Table 6).

**Table 6.** Pre-enrollees 2021-2

| CAREER_CODE | N   | S   | Grand total |
|-------------|-----|-----|-------------|
| 16          | 25  | 65  | 90          |
| 17          | 74  | 125 | 199         |
| 18          | 17  | 62  | 79          |
| 19          | 39  | 94  | 133         |
| 22          | 28  | 69  | 97          |
| 23          | 17  | 51  | 68          |
| 24          | 56  | 109 | 165         |
| 25          | 38  | 87  | 125         |
| 31          | 28  | 62  | 90          |
| 71          | 25  | 48  | 73          |
| 94          | 17  | 54  | 71          |
| 95          | 54  | 99  | 153         |
| Grand total | 418 | 925 | 1343        |

Figure 6, makes it clear that the systems engineering program maintains its academic offer with a similar percentage in the periods before Covid 2019-1, 2019-2 and 2020-1, and the periods of Covid 2020-2, 2021-1 and 2021-2, so it can be said that it has not been affected in the labor to teach classes and offer the program. However, when analyzing the labor demand for systems engineers in the country and the demand of private companies, government institutions and the general population, there is no evidence of a significant increase in wanting to enter the program, even after demonstrating nationally the need for professionals in the area of computer science.



**Fig. 6.** Total percentage of students who pre-enrolled in Systems before and after Covid-19.

#### IV. CONCLUSION

The results for the engineering programs show a tendency to remain stable, however programs such as mechanical engineering are losing more applicants every day and with the pandemic this tendency is maintained. For the Systems Engineering program an increase was expected after almost two years of pandemic, and the high national and global demand for professionals in these areas, however no increase is found, so a study should be conducted on the specific causes that have not allowed applicants to be infected by the strong labor demand for systems engineering.

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