Analysis of Probability of Dropout, Continuation and Graduation through Markovian Chains of University Students in Bolivar, Colombia

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Abstract: In the process to reach a professional title can influence several factors, due to this a student entering a higher education institution can not assure with absolute certainty its future performance. The objective of this study is to formulate a model using Markovian chains to determine the relationship between the socio-economic level and the middle level (Saber 11) of students entering the Industrial Engineering program at the Universidad Tecnológica de Bolivar with his academic development emphasizing in the results of his tests Saber Pro and his probabilities of obtaining the professional title or of abandonment of the program. We identified the different directions of the university that manage the data of the students of the industrial engineering program, collected and ordered relevant data to achieve the construction of a model, which allows to predict, with support in probability values, the time that the Students pass in each of the levels of the Industrial Engineering program of the technological University according to their socio-economic level and test results to know 11°., And their possibilities of evolution level at level, until the possibility of obtaining a certain result in the tests know pro, achieve graduation or withdrawal. Of the program. The results obtained allow us to expand the knowledge about the academic performance of students in the different programs offered by the university, which is information of great importance for the UTB to establish strategies that accompany the student during the academic development of his career.

Keywords: Markov chains, academic performance socio-economic level, industrial engineering program, pro know-how, eleven-proof tests.

1. INTRODUCTION

This research is oriented to model a quantitative tool that will facilitate the evaluation of the academic development process of Engineering students in Bolivar, Colombia and the probabilities of progress using statistic and operations research tools that provide the number of periods required to pass from one level to another. In the future, this project will serve as a basis for universities to establish strategies to accompany the student during

the academic development of his career, and so to mitigate the negative consequences generated by the factors (socio-economic level and level of secondary education) that are analyzed in this project [1], [2] and [3].

2. THEORETICAL FOUNDATION

The SABER test 11° (before, Icfes) evaluation of the level of the Average Education from the year 2014 aligns with the evaluations of the Basic Education to provide information to the educational community in the development of the basic competences that a student must develop during the passage through the school life. In addition to being a tool that feeds back to the Education System, the SABER test 11 has as objectives, according to the provisions of decree 869 of 2010, the following [1]:

- Check the degree of development of the skills of students who are finishing the eleventh grade of secondary education.

- Provide elements for the student to carry out their self-assessment and development of their life project.

- To provide educational institutions with pertinent information on the competencies of aspirants to enter higher education programs, as well as those who are admitted, to serve as a basis for the design of programs of academic leveling and prevention of dropout at this level .

- Monitor the quality of education in the country's educational establishments, based on the basic competency standards and quality referrals issued by the Ministry of National Education.

- Provide information for the establishment of value-added indicators, both for secondary education and for higher education.

- To serve as a source of information for the construction of quality indicators of education, as well as for the exercise of inspection and monitoring of the public educational service.

- Provide information to educational establishments that offer secondary education for the exercise of self-assessment and to carry out the consolidation or reorientation of their pedagogical practices.

- Provide information that serves as a strategic reference for the establishment of national, territorial and institutional educational policies.

The tests "know pro" is the State Quality Examination of Higher Education applied directly by the ICFES. The presentation of this examination is a compulsory requirement to graduate from undergraduate, have as a function:

- Check the degree of competence development in the next students to complete their higher education.

- Produce indicators of value added in higher education. Compare the existing skills before entering and finishing the race.

- Serve as a source of information to build evaluation indicators on the quality of programs and institutions.

3. METHODOLOGY

The methodological scheme that was developed for the execution of this project was stipulated in stages. These are described below [4], [5], [6], [7]:

1. Identification of the fundamental variables of the project. Socio-economic level, the level of tests to know 11th, academic development and test results know pro of students who first entered the industrial engineering program of the Bolivar University of Technology.

2. Collection of all relevant information. The research group approached the Directorate of Planning and Quality Management and requested the database of students of industrial engineering that entered from the first period of 2002 until the first period of 2012 and general result of the tests to know 11°.

3. Comprehensive analysis of information. The process of analysis of the information began to be carried out after the first database was obtained, finding inconsistencies that were later resolved.

   For the purposes of the project, it was necessary to use a statistical measure of dispersion around a certain central value, which in this case correspond to the national average obtained in each period, the above in order to categorize the results obtained in the tests Know pro Based on the above, the following classification was reached [8]:

   - The interval comprised by the mean value of the +/- standard deviation is the one corresponding to the tests know pro "MEDIUM level".

   - The interval comprised by the value of the mean minus three times the standard deviation and the value of the mean less than twice the standard deviation corresponds to the tests know pro "LOW level".

   - The interval comprised by the value of the mean plus two times the standard deviation and the value of the mean plus three times the standard deviation corresponds to the tests know pro "high level".

4. Formulation of the transition diagrams of the Markov Chains. When formulating the Markov chains it is necessary to identify the different states that will intervene in this, for the model of this research will be [9], [10]: the stratum with which the average, high and low student enters associated with its result in the tests know 11o, levels Of the program (0 to 9), partial withdrawal associated with the levels, total withdrawal associated with the levels, levels at which evidence can be known know pro according to university guidelines (seventh, eighth and ninth), possible Results that can be obtained by a student when presenting the tests know pro (high, medium and low) and lastly the state of graduation. The next step is to calculate the transition probabilities associated with each state and graph the behavior of the chain by means of a transition diagram to verify if its approach is correct. It should be noted that for the sample studied, a subdivision was presented that uses the Icfes qualification system in the test results to know 11o.According to this system, students' scores can be categorized as high (score 71-100), medium high (score 46-70), medium low (score 31-45), low (score below 30) [11].

5. Solution of the model. The processing and solution of the Markov chain model was obtained using Excel software. For the Markov chains of absorbent chains, the solution procedure uses matrix relations, which determine the average number of semesters, that a student spends at each of the nine levels of the program before graduating or withdrawing altogether; As well as the probabilities of absorption, which indicate the probability that a student entering UTB's Industrial Engineering program leaves before graduating or completes a successful graduate.

   The steps to follow for the solution of the proposed model start with the calculation of the matrix T of the expected number of transitions up to absorption [12], which reflects the expected number of lapses expected to pass an Industrial Engineering student at each of the levels Of the stroke, before absorption by the absorbing states Retirement or Graduation by means of the equation:

$$T = (I - Q)^{-1} \qquad\qquad (1)$$

where T: matrix of transitions up to absorption

   I: identity matrix of the same order of Q

   Q: matrix of probabilities of non-absorbing states

It is continued by finding the TR matrix of conditional probabilities of absorption by the equation.

$$TR = (I - Q)^{-1} R \qquad (2)$$

where R: transition matrix from non-absorbent states to absorbent states.

6. Analysis of the results of the matrix. At this stage the results obtained by the respective matrices must be studied, their meaning within the context of the research, they analyze if they met the objectives initially raised. The questions of interest must be answered according to the data obtained [13], [14].

7. Observations and conclusions. The observations should establish the atypical phenomena that were found during the previous stages of the investigation, establishing general conclusions about the formulated model.

4. RESULTS AND DISCUSSION

The notations used are described below:

- BM = low stratum, tests know 11th. Medium
- MM = Middle stratum, tests to know 11°. Medium
- AM = Stratum high, tests to know 11th. Medium
- 0BMB = Level 0, low stratum, tests know 11th. Medium low
- 0BMA = Level 0, low stratum, tests know 11th. Medium high
- 0MMB = Level 0, middle stratum, tests know 11th. Medium low
- 0MMA = Level 0, middle stratum, tests know 11th. Medium high
- 0AMB = Level 0, high stratum, tests know 11th. Medium low
- Academic Novels 0-9
- (0-9) RP = partial withdrawal niel (0-9)
- Socioeconomic level
- Low: 1, 2
- Medium: 3, 4, 5
- RT: total withdrawal

The analysis of probability of desertion, continuation and graduation through markovian chains of industrial engineering students of the Bolivar University of Technology is shown below, Figure 1 and 2.

According to the results obtained: The industrial engineering program does not admit students with test results to know 11°. Neither highs nor lows only enter with 11° means tests (half high and medium low).

Fifty-eight per cent of the students of the students who entered with an average socio-economic level and some tests know 11 average are retired and 42% graduate. Likewise, the students who entered with an average stratum and tests to know 11 middle high school students have a 26% probability of going to total withdrawal and 74% of applicants to grades.

Of the students who entered with a low socio-economic level and some tests to know 11 middle-lows 67% were totally withdrawn and 33% graduated, while the students who entered with a low socio-economic level

and some tests know 11 Medium high. Students who entered with a low stratum and a test of 11 high school students have a 23% chance of withdrawing altogether and a 77% chance of graduation.
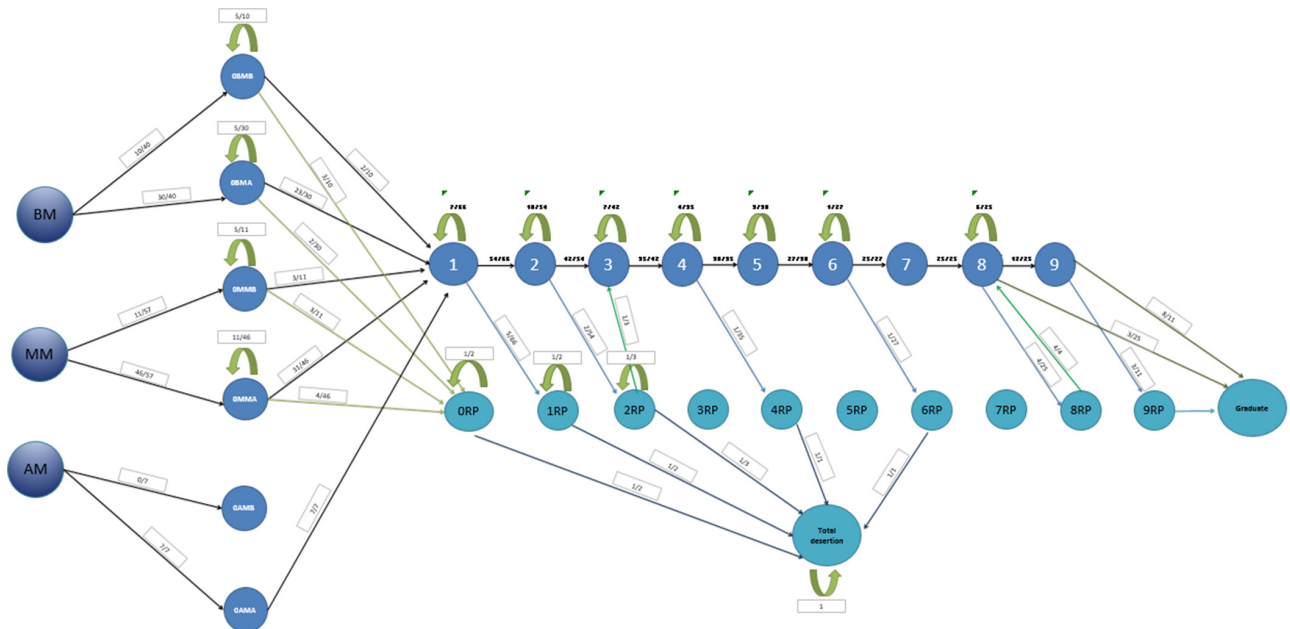

Figure 1: Analysis of probability of desertion, continuation and graduation through markovian chains of industrial engineering students of the Bolivar University of Technology: Graduate diagram
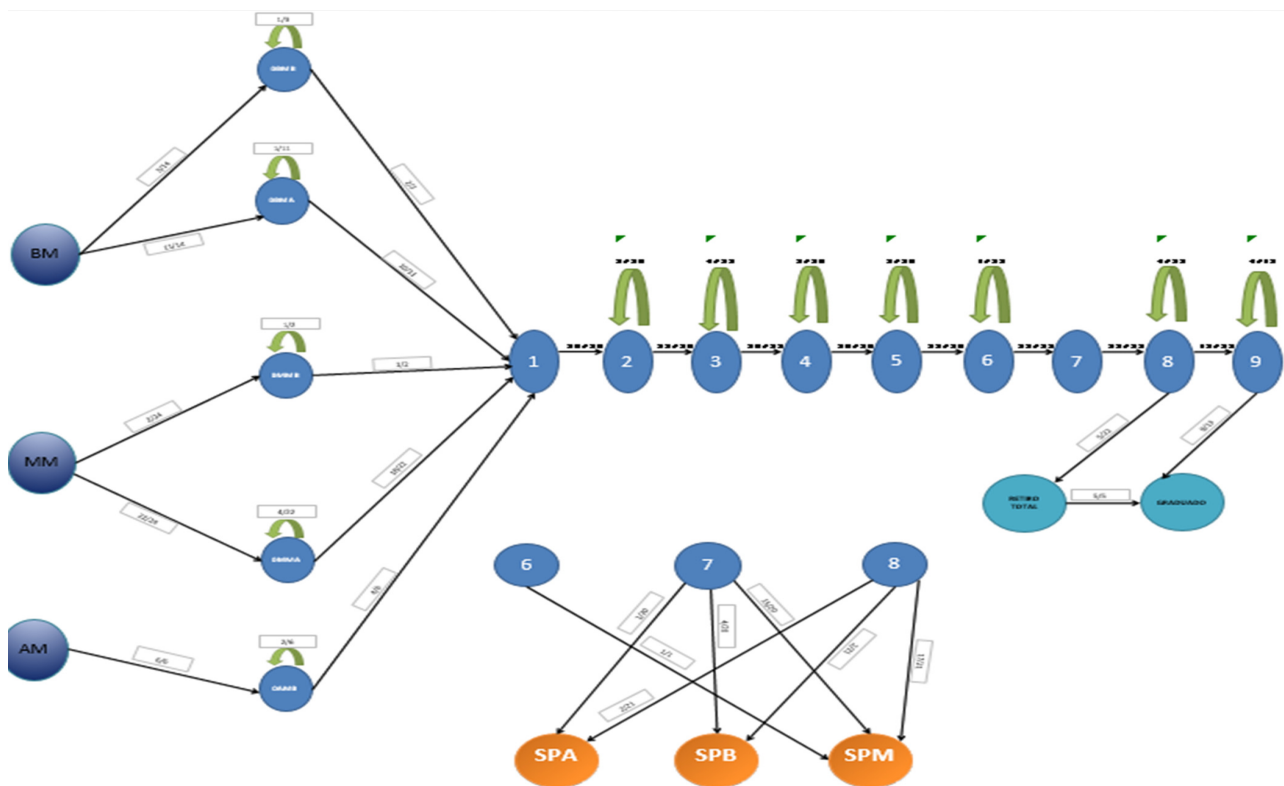

Figure 2: Analysis of probability of desertion, continuation and graduation through markovian chains of industrial engineering students of the Bolivar University of Technology: know pro diagram

Students who enter with a low stratum and tests to know 11 high middle school have a 17% complete withdrawal and 83% of them aspire to degree.

The analysis of the previous percentage according to the socio-economic level and result test results know 11°. It makes clear that in the industrial engineering program the results that students have in their tests know 11°. Regardless of their socio-economic status, their chances of graduation or withdrawal from the program increase or decrease. Thus it can be affirmed that the percentage of students of the program of industrial engineering that retires more have a low socio-economic level and its results in the tests to know eleventh were also low.

On average, the number of semesters a student in the engineering program is expected to graduate is 11. The following table shows this behavior by associating socio-economic levels and results in the tests. Finally students entering the program with average socio-economic level and tests to know 11° average high.

Table 1
Semesters required by students according to their socio-economic level and test results to know 11°.

Initial State	*Semesters Required*
Low-stratum students who tested 11 medium-low (BMB)	12
Low-stratum students who tested 11 mid-high (BMA)	11
Middle stratum students who presented tests knew 11 middle low (MMB)	11
Middle stratum students who presented tests know 11 middle high (MMA)	11
Upper-stratum students who tested 11 mid-high (AMA)	11

In addition, the information provided by the model shows that levels 1 and 2 are the ones most likely to have total withdrawal with 17% and 9%. At levels 7, 8 and 9 there is a 100% probability that Students who reach these levels reach grade. Students who withdraw partially at levels 0, 1, 4 and 6 are 100% likely to be absorbed by the total withdrawal.

A particular case occurs at level 5, where no student withdraws partially. Students who withdraw partially at levels 8 and 9 have a 100% probability of graduation.

5. CONCLUSION

This research formulates a Markovian model to predict the academic performance of students in the industrial engineering program of the Bolivar technological university. Their results associate the process of academic performance of the students of the program with respect to two factors: the socio - economic level and results in the tests to know 11º. This model can be implemented for different programs of the University and in this way to finish the proportion of students who retire, how long they take to graduate and how many graduates according to the factors mentioned above. But we must keep in mind that progress

Dynamics of the student in their studies, are the result of multiple factors. In short, the Markov model is a useful alternative for university interpretation and estimation.

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