

# Data Analytics for Admission Process: Bachelor of Engineering Program

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**Abstract.** Higher education provides opportunities to many occupations, influencing one's career. Higher education admissions processes vary by country or university, from reviewing materials to admissions decisions. Different admissions philosophies may influence applicants' eligibility for higher education and admission versus choice of admission. However, the intense competition among hundreds of applicants has compelled universities to upgrade their recruitment procedures to accept students with exceptional potential. Data analysis procedures have been applied in many areas to extract valuable insights from available data. Many industries acquire, store, and analyze data to make strategic decisions and gain valuable knowledge. Data analytic has been applied in the education industry to facilitate improved decisions in various sectors, including the development of tailored and dynamic learning programs, the enhancement of grading systems, and the prediction of a student's optimal future career. Therefore, the purpose of this research is to apply data analytics to facilitate a data-driven decision process based on prospective and current student data. The academic performance of current engineering students in both university and high school is analyzed in this study. Since there are 13 engineering programs considered, the different environmental settings of schools or engineering programs are also taken into account. Additionally, the impact of COVID-19 on the teaching and learning process in recent years was considered. The results were used to enhance the first-year engineering academic support program and evaluate the effectiveness of the current admissions procedure.

**Keywords.** Data analytics, Admission process, Data-driven decision making, Educational management

## Introduction

Higher education provides access to numerous occupations, allowing individuals to shape their careers. Admissions processes for higher education vary by country and institution, from the application to the admissions decision. Various admissions philosophies may affect candidates' eligibility for admission to higher education institutions. However, the intense competition among hundreds of applicants has driven institutions to improve their recruitment strategies for prospective students. Universities must resolve a number of obstacles in order to have an effective admissions process,

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including balancing academic standards with diversity, standardizing test scores, and grade inflation. Standardized examinations such as Thai Professional Aptitude Test (TPAT), Thai General Aptitude Test (TGAT) and Applied Knowledge Level (A-Level) are generally used to gauge academic competence [1]. TPAT focuses on assessing skill-based competencies in five main professions, including medicine, science, technology, engineering, education, architecture, and the fine arts. TGAT focuses on measuring aptitude including English communication, critical and logical thinking and prospectiveworkforce competencies. A-Level focuses on evaluating the general academic knowledge of candidates in applied mathematics, applied science, physics, chemistry, biology, Thai language, social studies, English and foreign languages. Candidates may submit applications for any subject they desire. Each academic program will define the list of A-Level subjects that are necessary for admission. Concerns exist regarding the fairness and reliability of these tests, as well as their ability to accurately predict a student's collegiate success [2-3]. Certain high schools' grade inflation has also made it impossible for institutions to accurately evaluate students' academic performance. A student's socioeconomic status can have a substantial effect on student academic performance and opportunities. Universities face the challenge of resolving their dedication to significance admissions with the need to consider socioeconomic factors. In response to this challenge, universities are exploring novel admission procedures such as test-optional policies, a greater emphasis on holistic applications, and more innovative student selection methods [3].

Data analytics can assist in making better decisions in many industries, resulting in more efficient operations and enhanced overall performance. In education, data analytics have brought changes to various areas, including customizing dynamic learning programs, grading systems, reframing course materials and predicting future careers [4]. By examining student data, data-driven career predictions can reveal their true interests, weaknesses, and strengths, allowing them to make informed career decisions [5]. Classification based on logistic regression analysis employed to predict course dropouts and develop tutoring plans, resulting in a 14% reduction in dropout rates compared to previous academic years without dropout prevention measures [6]. Data analytic was also used to select students by providing objective, data-driven insights into their performance and potential. The ultimate goal was to maintain a balance between academic standards and diversity to admit students with the highest probability of success in university and beyond.

Several studies have applied data analytics to the admissions process [7-9]. Predictive analytics has been used to predict the probability of future outcomes by analyzing past data. Predictive analytics was used to determine which applicants to higher education were most likely to succeed in a certain program or institution. This made it easier for admissions authorities to choose which applicants to accept [7]. Enrollment forecasting, using historical data, was employed to predict the number of students who may enroll in a specific program or school. This assisted universities in making decisions about how many students to admit each year and in planning for future enrollment [8]. Applicant segmentation involves categorizing candidates into various groups based on their characteristics and behaviors. This assisted admissions staff in identifying which groups of candidates have the highest chances of success in a specific program or organization [9]. Data analytics enables more precise and efficient application reviews. Automated methods were used, for example, to highlight applications that require closer examination or to scan them for essential data points [10]. Data analytics can also promote inclusion and diversity in higher education admissions.

For instance, data was used to identify areas where minority groups were underrepresented in applications and to develop strategies to increase their participation [10]. Although data analytics can be a useful tool for improving the admissions process, the accuracy of the results is dependent on the quality of the data used for analysis. Insufficient or unclear data can lead to incorrect assumptions and decisions. Technical skills are required for data analysis and the use of data analytics tools. Furthermore, while data analytics can provide insights and conclusions, their interpretation is subjective. Misinterpretation of data analytics outcomes can lead to incorrect conclusions and decisions. Despite these limitations, data analytics can be a valuable tool for enhancing the admissions process when combined with other approaches, such as expert opinions and qualitative evaluations.

Consequently, the objective of this study is to apply data analytics to prospective and current student data to assist in a data-driven decision-making process. The academic performance of current engineering students in the university, as well as their high school performance, was monitored and analyzed. The outcomes were utilized to enhance the academic support program for first-year engineering students and assess the effectiveness of the current admissions approach. Data analytics was used to analyze student data and identify the factors that had the greatest impact on student success. The data-driven decision-making process then employed to adjust the admission criteria and improved the efficiency and fairness of the admissions process. Furthermore, data analytics was used to monitor the effectiveness of the admissions process over time and facilitate continuous improvements.

## **1. Data Analytics**

Data analytics is the discipline of analyzing raw data to derive conclusions and make decisions. The objective of data analytics is to provide responses to questions and assist in the formation of conclusions. There are various categories of data analytics, depending on the desired outcome. Four fundamental categories of data analytics exist: descriptive analytics, diagnostic analytics, predictive analytics, and prescriptive analytics [11]. As illustrated in Figure 1, these categories are subdivided based on their complexity levels and contribution to value addition. In order to provide insightful perspectives on the past, descriptive analytics manages unprocessed data from multiple data sources. However, these results merely indicate that something is incorrect or correct based on the query of what occurred, without providing an explanation for why this occurred. The objective of diagnostic analytics is to determine the cause and effect of an occurrence by analyzing the past. The purpose is to identify causes by comparing previous occurrences. Obviously, the response is typically presented in terms of probability, possibility, or a distributed outcome. Predictive analytics provides projected results. Utilizing the results of descriptive and diagnostic analytics, it identifies clusters and outliers and forecasts future trends, making it a valuable tool for forecasting. It provides numerous advantages, such as sophisticated analysis based on machine learning or deep learning and a proactive approach enabled by predictions. The purpose of prescriptive analytics is to prescribe precisely what action to take to eliminate a potential problem or capitalize on an emerging trend. It employs sophisticated tools and technologies, including machine learning, business principles, and algorithms, which makes its implementation and management complex. This cutting-edge form of data analytics requires external

information in addition to internal data due to the nature of the algorithms upon which the analysis is based..

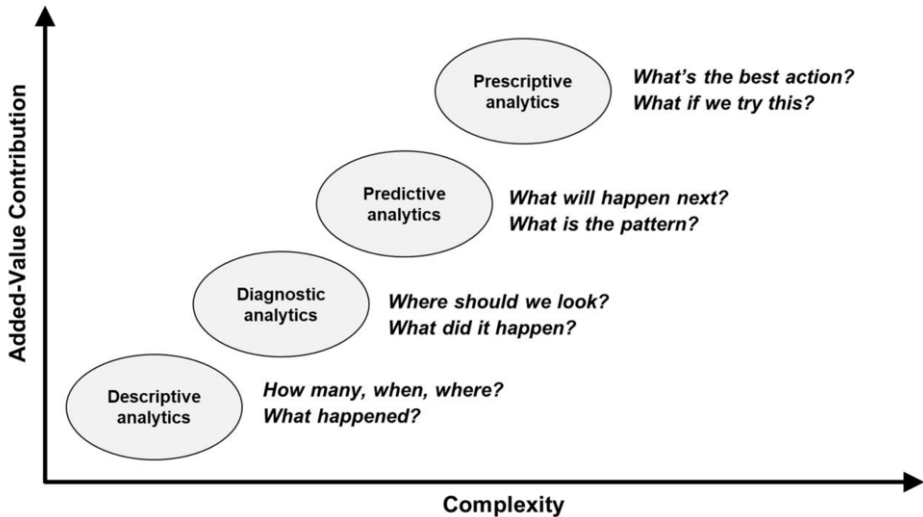


Figure 1. Types of data Analytics.

A data analytics framework is a standardized method for analyzing data and making intelligent decisions based on the insights obtained from the analysis. As shown in Figure 2, a typical data analytics framework consists of five steps: defining the problem, collecting and cleansing data, virtualizing data, data-driven decision making, and monitoring and evaluation. Defining the issue assists in concentrating efforts and ensuring that the analysis is significant and relevant. The data must be cleansed and preprocessed to eliminate any errors or inconsistencies and make it ready for analysis. Perform an analysis that identifies relationships, trends, and patterns by visualizing the data. Perform the analysis in order to make decisions based on the data by interpreting the results using the appropriate statistical analysis. Continuously evaluate and monitor the results of the analysis to ensure that the decisions made are producing the intended results and to make any necessary adjustments. This framework provides a systematic approach to data analytics, ensuring that the analysis is comprehensive, precise, and relevant [12].



Figure 2. Data analytics framework.

## 2. Current Admission Process of Bachelor of Engineering Program

Thailand has a centralized admissions process for high school graduates and those with equivalent qualifications. All university applications must be submitted through the Thai University Central Admission System (TCAS). TGAT, TPAT, and A-Level are the three most important examinations. Centralized examination results enable a more consistent evaluation of student performance. However, the three types of entrance examinations are not administered simultaneously. As a result, TCAS divides admission into four time periods: the portfolio round, the quota round, the admission round, and the direct admission round. Faculty and university requirements will determine the admissions requirements. The majority of universities have admission requirements that include transcripts, TCAS scores, a portfolio, and an interview. Some universities may have partnerships with certain schools, such as student collaboration initiatives or summer camps. These institutions may have admissions quotas for specific school disciplines.

**Table 1.** Admission requirements for university and engineering faculty programs for 2022 academic year.

Requirements	Portfolio		Quota	Admission	Direct Admission
	Uni	Fac	Uni	Uni	Uni
Accumulated Grade point average (GPAX)	✓	✓	✓	✓	✓
Portfolio	✓	✓			
Interview		✓			✓
Thai General Aptitude Test (TGAT)				✓	
Thai Professional Aptitude Test (TPAT)				✓	
Applied Knowledge Level (A-Level)			✓		
Particular requirements e.g. International Baccalaureate, particular certificate, or sport performance		✓	✓		

**Table 2.** The number of students admitted to university and engineering faculty programs in each round for 2022 academic year.

Curriculum	Plan	Portfolio		Quota	Admission	Direct Admission	All Round		
		Uni	Fac	Uni	Uni	Fac	Uni	Fac	Total
Manufacturing Eng.	40	10	0	10	20	0	40	0	40
Computer Eng.	80	20	15	15	10	0	45	15	60
Artificial Intelligence Eng.	20	20	15	5	10	0	35	15	50
Biomedical Eng.	40	0	0	0	0	0	0	0	0
Environmental Eng.	30	10	0	10	0	0	20	0	20
Industrial Eng.	60	10	0	30	20	0	60	0	60
Chemical Eng.	60	5	0	20	10	0	35	0	35
Mechanical Eng.	80	30	0	20	10	0	60	0	60
Mechatronics Eng.	35	10	0	15	5	0	30	0	30
Mining and Materials Eng.	75	30	0	20	15	0	65	0	65
Innovation Engineering and Management*	50	10	35	10	10	0	30	35	65
Civil Eng.	60	0	0	0	0	0	0	0	0
Electrical Eng.	70	0	0	0	0	0	0	0	0
Engineering	-	85	30	40	50	10	175	40	215
<b>Total</b>	<b>700</b>	<b>250</b>	<b>85</b>	<b>205</b>	<b>150</b>	<b>10</b>	<b>605</b>	<b>95</b>	<b>700</b>

In this case study, prospective university students were recruited through two channels: university programs and faculty programs. Except for special programs such as sport or scientific quotas, the majority of admissions routes did not include an interview. The interview for the engineering program was only scheduled for the portfolio round (TCAS1), as no national test score was required. Table 1 illustrates the university and engineering faculty admission requirements for each round for academic year 2022. From Table 1, the portfolio round admits the most students (approximately 48%), followed by the quota round (approximately 29%). Although the interview was conducted with prospective students from faculty entrancement channels to evaluate their technical skills and motivation, the first round of requirements did not have the central standard to recruit students from faculty entrancement channels. Due to the variation in grading systems, standards, and course offerings between schools, the average cumulative grade point average (GPAX) of students from each school cannot be used as a standard. When comparing the GPAX of students from various institutions, it was essential to account for these differences. Students at the university in the case study had two opportunities to select their engineering majors: upon admission and after completing their first semester at university.

In the case that candidates decided their major after completing their first semester, they must declare general engineering as their major on admission. Their majors were determined by their grades at the conclusion of their first semester as general engineering majors. However, certain programs (such as Innovation Engineering and Management or Artificial Intelligence Engineering) had specific requirements, such as an international certificate or a related certificate, based on the specifics of each engineering field. Some programs (e.g., Biomedical Engineering, Civil Engineering, and Electrical Engineering) did not admit students until the conclusion of the first semester. Table 2 demonstrates the number of students admitted in each round to university and engineering faculty programs for the academic year 2022. To facilitate a data-driven decision-making process, prospective and current student data were analyzed using data analytics. Current high school and college engineering students' academic performance was analyzed. Various educational and engineering program contexts were also taken into account. The section that follows discusses the particulars of implementing data analytics.

### **3. Implementation of Data Analytics for Admission Process Enhancement**

This study utilized descriptive data analytics to evaluate the efficacy of the 2022 student admission strategies and to investigate the factors that impacted the quality of admitted students as a guide for the development of future student admission strategies. This study utilized data analytics based on the following conceptual framework.

#### *3.1 Defining the problem:*

The purpose of data analytics was to enhance the admissions strategies for the Faculty of Engineering in order to recruit high-quality students.

#### *3.2 Collecting and cleansing data:*

Approximately 1,500 first-year engineering students' data were collected during the 2021-2022 academic year. For the purposes of enhancing the academic support program

for first-year engineering students and assessing the efficacy of the current admissions process, the university and high school academic performances of students were analyzed. Before analyzing data, it was necessary to clean the data. This study identified and corrected errors, inconsistencies, and inaccuracies in a dataset before conducting the analysis. This round identified mistakes in spelling, incorrect school locations, and absent students from special programs. Researchers must contact students in order to correct these errors.

### 3.3 Visualizing data:

Visualizing data allows to access and analyze the data typically involves creating a view. The data visualization has advantages in that it eliminates the need to replicate data across various systems, enables real-time access to data sources for faster decisions, and provides a unified view of data that facilitates the identification of patterns and insights. This study employed Google's Looker Studio [13], an online tool for transforming data into customizable, informative reports and dashboards. The information of first-year students admitted for the academic years 2021 and 2022 was analyzed. Several factors were analyzed such as the school name, the school location, the student GPAX, the parent incomes, the student hometown locations, the admission advertising activities, the admission procedure, and the admission criteria. Finally, the overall information of first-year students, including school name, school location, admission method, and current student status, was taken into consideration. The performance of students in their first semester courses, including their grades in each subject, was also analyzed, and the visualization can be categorized by major and admission type.

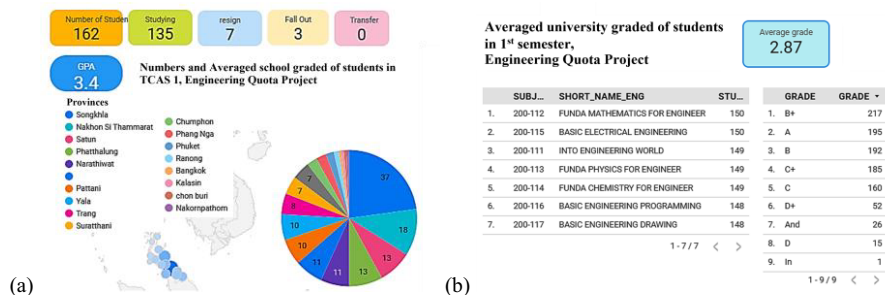


Figure 3. Examples of data visualization for the 2021 engineering quota program for first-year students: (a) the number of students in each province and (b) the average grade in each first-year course.

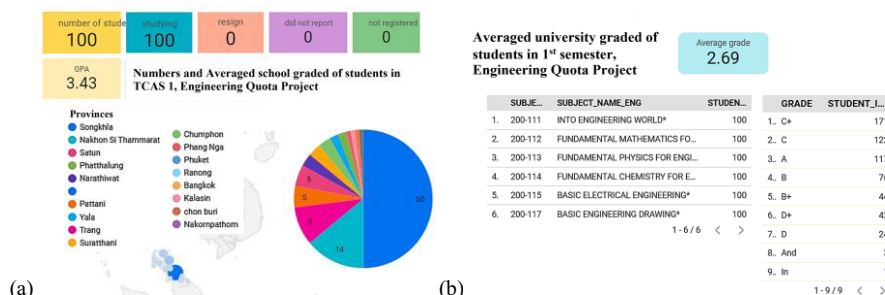


Figure 4. Examples of data visualization for the 2022 engineering quota program for first-year students: (a) the number of students in each province and (b) the average grade in each first-year course.

Figure 3 (a) shows the average grade, school location, and current student status of 2021's first-year engineering quota program participants, while Figure 4 (a) shows 2022's. Figure 3 (b) illustrates the first semester grades of 2021 engineering quota program students by major, while Figure 4 (b) illustrates those of 2022. Figures 3 and 4 demonstrate that, in both years, first-round admitted students, such as those from the engineering quota program, had lower average scores in the majority of first-semester courses than second-round admitted students. This could be due to issues with GPAX and portfolio assessment standardization. However, students from special admission programs established by the Faculty of Engineering during the first round, which either required a specific high school GPA in math, basic sciences, and English or graduates from affiliated or collaborative institutions, continue to have high test scores. Therefore, the first-round admission must be assessed. The majority of students were from the university's home province or neighboring regions. Figures 5(a) and 5(b) illustrate the first-semester grades for popular and unpopular majors among 2021 students. Figure 5 demonstrates that civil, electrical, and mechanical engineering perform better than other fields. Expected as the student with the higher grade achieves the major. First-semester GPAs for unpopular disciplines were lower. The curriculum chairman used the results to develop academic activities at the curriculum level, while the Faculty of Engineering organized academic activities that enhanced student performance.

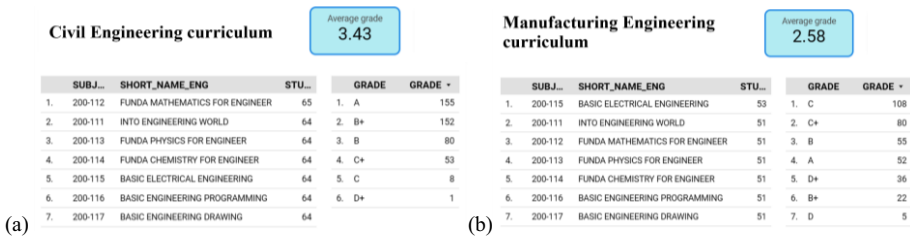


Figure 5. Data visualization for each first-year student curriculum in 2021: (a) popular curricula and (b) undesirable curricula.

### 3.4 Data-driven decision-making:

Based on data analysis and virtualization, the engineering admissions process must be revised to accommodate top students. Consideration was given to the evaluative standards and curriculum entry quantity of each round. Data-driven decision making has changed the Faculty of Engineering's admissions procedure for 2023, notably the first round (portfolio). A study of the data revealed that the GPAX is unable to reflect student qualification as accurately as national test scores. Thus, the TGAT was required for admission in the first round. In order to standardize interviews, admission interview committees were provided with information on affiliated or partner institutions, as well as curriculum-specific inquiries. Candidates were assessed using an interview rubric to ensure consistency. Some direct entry major numbers were modified to match their characters in order to select the best candidates for faculty positions, compare and discuss interview scores from various teams, and select the best candidates for faculty positions. Analysis of the data indicates that admitted students were from adjacent schools. To increase student diversity, it was necessary to investigate alternative areas. The results of the data analysis were also used for academic activity planning at both the curriculum and Faculty levels. Before starting of the first semester, the academic preparation program for the course of 2023 was one such activity. Since the 2021 and 2022 academic



years most high school students were not in the schools due to the COVID-19 situation and the analyzed results showed that most 2021 and 2022 students had difficulties with basic mathematics, the 2023 student academic preparation program includes the basic mathematics. The faculty allocated an additional 100,000 THB for curriculum-specific academic activities so that each curriculum chairman can organize student activities to enhance student performance.

### *3.5 Monitoring and evaluation:*

To evaluate the success of our method, the 2023 admission results were analyzed. According to the admission revision process, the modification of admission procedure for the 2023 academic year includes: (1) requiring more standard test scores and documents; (2) establishing a standard interview and evaluation based on rubrics for the interviewing committees; and (3) adjusting the number of students admitted in each round to reflect the dynamics of the current admission process. As a result of the modification, the first three rounds of 2023 admissions showed promising results. There were, (1) the number of students were not decreasing while other faculties faces the decreasing number of candidates; (2) the admission scores of accepted candidates were higher than other faculties or universities; and (3) the third round competitive rate was at 1 to 8.34 which was better than the top engineering school of the country (at 1 to 9.90). To continuously monitoring our data, the data collection on relevant indicators, analysis of the collected data, and interpret data responsind the objective were planned for the whole year. The activities was repeating each year to enable the use of reliable data to inform the continuous enhancement of data analytics. The results were presented at the monthly curriculum chairman meeting and the monthly faculty of engineering committee meeting. Thus, the results of the analysis were utilized at both the policymaking and operational levels.

## **4. Conclusion**

This research implemented descriptive data analysis for two purposes: (1) planning admission procedures to enhance the quality of students admitted to engineering programs, and (2) planning the appropriate curriculum-level and extracurricular academic activities for students. The five phases of data analysis consisted of problem definition, data acquisition and cleansing, data visualization, data-driven decision making, and monitoring and evaluation. The data of approximately 1,500 engineering students from 2021 and 2022 academic year at the case study university was collected including structured and unstructured student application forms, transcripts, academic records, standardized test scores, and interview data which were initially collected from a variety of sources. The performance of university engineering students during their first semester was also collated. The data were then cleaned, preprocessed, and converted into an readily analyzed format in order to eliminate any missing or irrelevant information. The admissions information was visualized using Looker Studio, a data visualization application, to facilitate comprehension of the findings and the making of informed decisions. It was observed that admissions requirements, school names, and school locations affected the quality of admitted students. The admissions process was modified for the 2023 academic year based on the findings of the data analysis. National educational examinations, specific certificates, and rubric-based evaluations were added

to improve the student selection process. The 2023 admissions results demonstrated an encouraging trend. Continuous monitoring and evaluation of the effects of modifications to the admissions process have been carried out. Future regression analyses can further investigate the relationships between the various students performance factors across all four years. Additionally, data clustering techniques can be used to identify similar categories of student performance that can be utilized to improve academic support programs for engineering students.

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