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Application of Minitab 17 Statistical Software to Analysis of Students of the Faculty of Engineering, Thai-Nichi Institute of Technology

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***Abstract*- This paper utilize Minitab 17, a statistical analysis software, to study the significance of some factors relating to enrolment and retention decisions of engineering students, Thai- Nichi institute of technology. The student data from 2008 to 2015 are analysed. While the number of new students and number of study programs increase together with time, an analysis of variance (ANOVA) shows that the number of study programs has no significant effect on the number of new students. Regarding the retention rate, analysis of the data shows that if the base is chosen to be the second year students, there is no significant variation between batches of students in each field.**

***Keywords*- Statistical software, Regression analysis, Analysis of variance, student enrolment**

I. INTRODUCTION

Decision making in industries and many enterprises usually involves statistical data. This has made statistical analysis software an indispensible and very useful tool in industrial engineering [1]. Minitab 17 is one such software which has become very popular due to its power and ease of use. In this paper, the program is used to analyse some aspects of engineering students enrolling in the Faculty of Engineering, Thai-Nichi Institute of Technology (TNI).

Thai-Nichi Institute of Technology was established in 2007 with three undergraduate Faculties, i.e. the Faculty of Engineering, Faculty of Business Administration and Faculty of Information Technology. The number of students and the number of curricula have increased ever since. From 2008-2015, the number of curricula of TNI have increased from 6 to 14, while the total number of new students increased from about seven hundred to about thirteen hundred as shown in Fig. 1, plotted by the Minitab 17 program. While the data points do show considerable variation, the increasing trend is undeniable in both cases. This would naturally lead to an assumption that there should be a correlation between the two variables, i.e. increasing the number of study programs would lead to an increase in the number of new students.

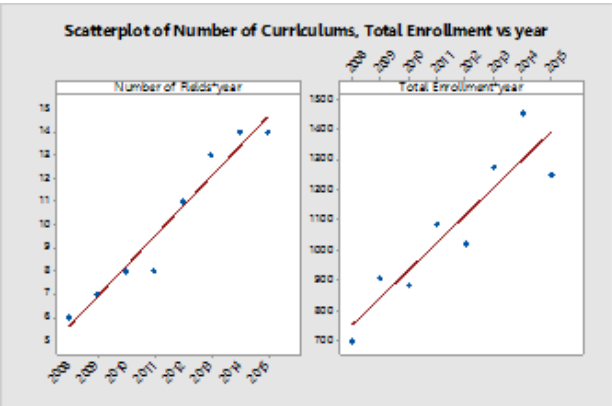

Fig. 1 The scatterplot of number of curriculums and number of students from 2008-2015

In many commercial enterprises, a standard marketing practice would suggest that one way to increase sale is to increase variety by introducing one or more new products. However, for an educational institution, it is not clear if such a practice would be beneficial. In other words, is it true that the more curricula, the grater the number of new students? A statistical analysis is needed to answer this question. The Faculty of Engineering of TNI is chosen to be a case study. In addition, the number of engineering students in each curriculum changes as students proceed to higher years. A consideration of the retention rate of students is therefore needed.

The Faculty of Engineering, TNI, started admitting new students in 2008 with only one study program, namely Automotive Engineering (AE). Two new curricula, i.e. Computer Engineering (CE) and Production Engineering (PE), were added in the following year. The Industrial Engineering (IE) and Electrical Engineering (EE) programs started in 2012 and 2013, respectively. The number of new engineering students follows an increasing trend similar to that of the university as will be seen later.

According to information gathered from yearly interview of new students, there are many factors involved in making decision about enrolment at TNI and the field of study. Most new students learn about TNI from: 1) TNI's website, 2) the information from other elder students who

are studying in this institute, 3) the recommendation of their teachers, and 4) Sakura camp activities organized by TNI. About the reasons of choosing engineering fields, students are interested in learning the Japanese language, getting high salary after graduation, looking for opportunities to work for Japanese companies, and planning to work or study abroad especially in Japan.

Factors related to student enrolment have been studied before. For example, MacGuire and Halpin [2] studied factors related to retention of engineering students at Auburn University, Alabama, U.S.A. The research used a qualitative study regarding the problem of retaining students in the engineering programs by interviewing students of various races. The results showed that the factors of persistence in engineering were the intention to stay, determination, self-regulating behaviour, coping skill, grade and mental preparedness. Corcoran, et.al, [3] studied the factors affecting the enrolment in engineering-related technical programs in community colleges. It aimed to look at the recruitment and retention problem of these colleges. Contributing factors for considering enrolment in engineering doctoral programs was studied in [4]. This research analysed two groups of people, i.e. graduate students enrolled in various engineering programs in Lebanon and the working engineers in several countries around the world working in different social and multicultural settings. An Independent t-test showed no significance between students and engineers' intention. An exploratory Factor Analysis provided four factors: professional attitude, social attitude, financial attitude, and subjective norm. Repeated measures ANOVA showed the professional attitude as the most important for participants followed by the financial attitude, the subjective norm, and the social attitude.

The growth in undergraduate engineering enrolment in North America has been studied by [5]. This research showed the trend of each engineering field of Canadian undergraduate engineering. The most interesting fields were electrical and mechanical engineering and the third was computer engineering. However, there had also been a drop in number of students enrolled in several engineering programs. The paper recommended activities to educate high school students about the challenges, career path, and rewards of engineering careers.

II. RESEARCH METHODOLOGY

The present study has two objectives, i.e. (1) to study enrolment decisions in relation to the number of curricula, and (2) to study the retention rate of engineering students. The research methodology is to perform graphical analyses and apply statistical analyses composed of factor analysis and regression analysis on the number of new students during 2008-2015 as shown in Fig. 2.

Fig.2 Research Methodology

For the analysis of the retention rate of engineering students, the graphical analyses are performed to compare the retention rate of each class of each group of incoming students. The objective is to study the retention rate of each engineering field and its trend.

III. DATA ANALYSIS AND RESULTS

A. Analysis of Variance: Regression Analysis

The numbers of new students in the Faculty of Engineering and in each study program are shown in Table 1 and plotted in Fig. 3. Straight line graphs are fitted to each set of data. It can be seen that there is an increasing trend to the number of new students for the whole Faculty in a similar way to that of the university as a whole. However, there is no clear indication that an introduction of a new study program would lead to a jump in the number of new students. In fact, when

TABLE I
NUMBER OF STUDENTS ENROLMENT
IN ENGINEERING FROM 2008-2015

Year	AE	PE	CE	IE	EE	Total
2008	158	52	91	-	-	301
2009	132	79	123	-	-	334
2010	150	72	134	-	-	356
2011	187	81	109	-	-	377
2012	138	51	83	32	-	304
2013	207	40	89	70	49	455
2014	121	80	88	55	86	430
2015	115	64	73	60	61	373

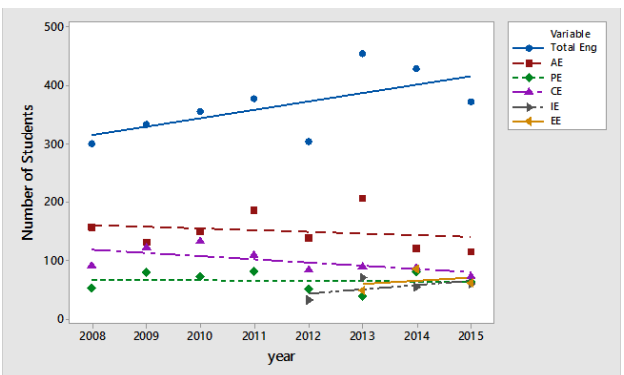

Fig. 3 Graphical analysis of the number of new students in Faculty of Engineering

the new IE program started in 2012, the total number of new students actually dropped. Therefore, while it can be said that the total number of students increases with time and concurrently with the increasing number of study programs, there is no clear cause-and-effect relationship for the number of study programs. Some programs such as computer engineering (CE) and production engineering (PE) appeared to have fewer new students when new curricula such as IE and EE started.

Using data from Table I, a regression analysis of the number of curricula to the number of new students each year is performed. Since the total number of new students is a count response, a transformation is needed [6] and is given by

$$Y' = (\sqrt{TotalEng} + \sqrt{TotalEng + 1}) / 2 , \quad (1)$$

where *TotalEng* is the number of new students enrolling in the Faculty of Engineering.

Factors involving the total number of new students are time (year) and the number of curricula which are categorical predictor factors. The regression analysis of the number of students with time together with the number of curricula is carried out by using Minitab 17 Statistical Software and the result of variance is shown in Table II.

TABLE II
REGRESSION ANALYSIS OF NUMBER OF NEW ENGINEERING STUDENTS WITH TIME AND NUMBER OF ENGINEERING PROGRAMS

Source	DF Adj	Adj SS	Adj MS	F-Value	P-Value
Regression	3	10.1280	3.3760	3.20	0.145
Year	1	0.2713	0.2713	0.26	0.639
Programs	2	4.2454	2.1227	2.01	0.248
Error	4	4.2199	1.0550		
Total	7	14.3479			

* Y is the transformed response according to (1).

The result from Table II clearly confirms that the number of curricula is not significant to the number of new students, since P-value from table II is greater than 0.05 at 95% significant level.

To gain further insight into the effect of introducing new study programs to the Faculty of Engineering, it is instructive to plot the total number of new students and the numbers in the AE, PE and CE programs for the year 2008 to 2011. This is done in Fig. 4. Clearly, the trend of new students for all three programs is increasing for the first four years. However, if the period is extended to the year 2015 as in Fig. 3, all three programs show different trends with the most pronouncing decrease in CE. This can only mean that introduction of new curricula to the Faculty drew students away from existing programs to new ones.

A different picture emerges if the total number of engineering students is considered instead of new students. Fig. 5 shows the total number of engineering students starting with the year 2010, which was the first year that the Faculty

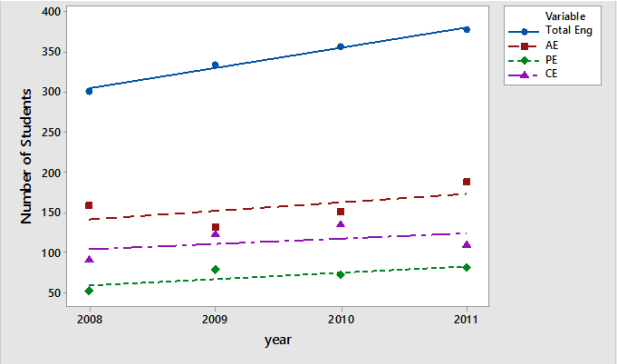

Fig. 4 Graphical analysis of the nembers of new students in the Faculty of Engineering for the years 2008-2011.

had students in all levels, togethere with total numbers of students in three separate fields. The two most recent curricula are not included since they are very new and do not have enough data for consideration. It can be seen that while the total numbers of students in two of the three fields do not show any discernable trend, one shows a definite decreasing trend.

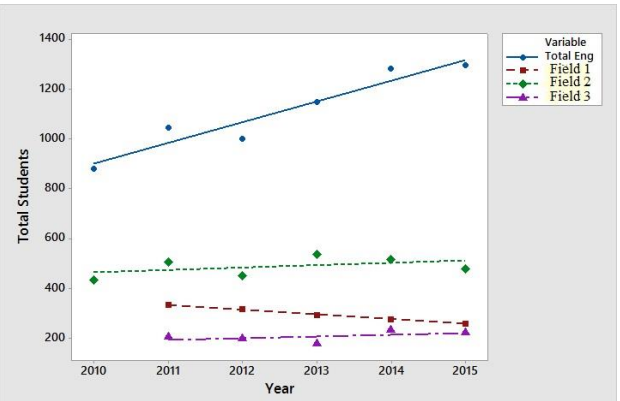

Fig. 5 Graphical analysis of the total number of students in the Faculty of Engineering and total numbers of students in three curricula.

To confirm the decreasing trend of students this curriculum, a regression analysis was performed and the result is shown in Table III. The result confirms that there is a strong correlation between the total number of students of this particular curriculum with time. Similar analyses for two other curricula do not show similar correlation but are not shown here. Such a result can serve as a "flag" of warning to the Faculty to analyse the cause, if any, of such decline and take corrective actions as needed.

TABLE III
REGRESSION ANALYSIS OF TOTAL NUMBER OF STUDENTS IN ENGINEERING CURRICULUM 2 WITH TIME.

Regression Analysis: Total students of curriculum 2 with time					
Source	**DF Adj**	**Adj SS**	**Adj MS**	**F-Value**	**P-Value**
Regression	1	3648.10	3648.10	334.69	0.000
Year	1	3648.10	3648.10	334.69	0.000
Error	3	32.70	10.90		
Total	4	3680.80			

B. Retention Rate Analysis

The other objective of this research is to analyse the retention rate of existing engineering students of each curriculum. The retention rate is defined as the percentage of remaining students of a particular year of study, e.g. 3rd year or 4th year, with respect to students in a base year. For the present study, only three curricular, i.e. AE, PE, and CE, are there are insufficient data for consideration.

Figs. 6, 7, and 8 show the retention rates of students in AE, PE, and CE, respectively, when the base is the first-year students of each field.

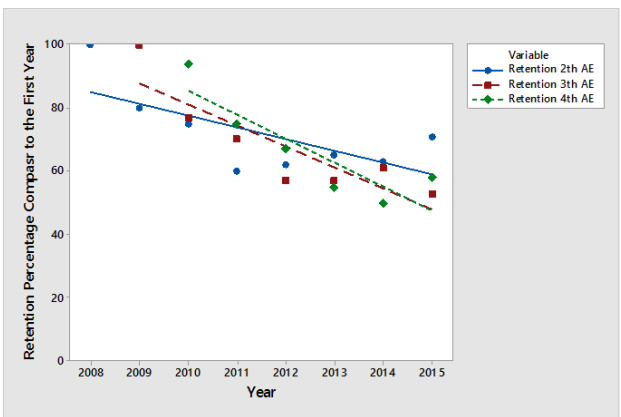

Fig.6 Retention rate of AE students with first-year students as the base.

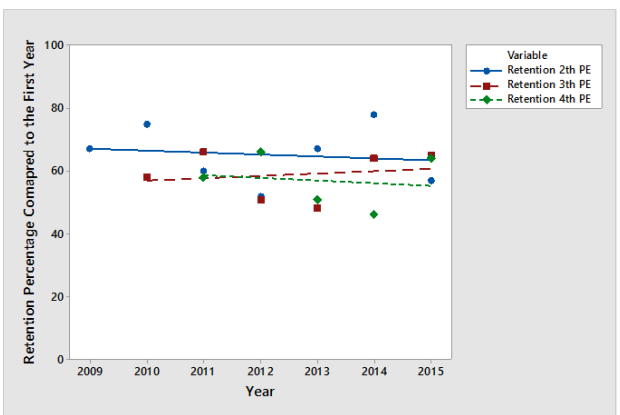

Fig.7 Retention rate of PE students with first-year students as the base.

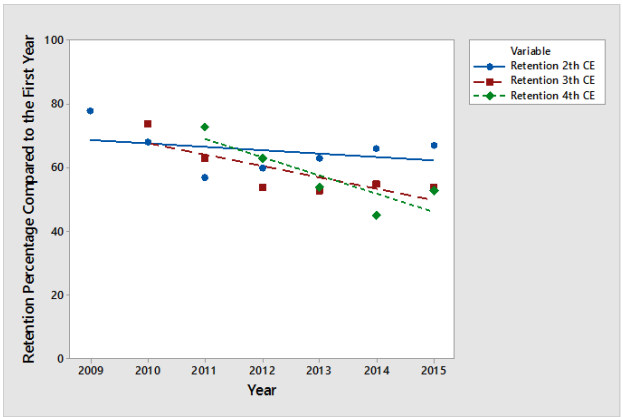

Fig.8 Retention rate of CE students with first-year students as the base.

It is a well-known phenomenon that first-year students in a private university usually decrease significantly when they proceed to the second year. Many first-year students decide to change their fields of study or try to enter other universities. Similar thing occurs at TNI and leads to a confusing picture for the retention rates of engineering students at TNI. However, if the base year is chosen to be the second-year students instead of the first-year, different pictures emerge. Figures 9, 10, and 11 show the retention rates of students in AE, PE, and CE, respectively, when the base is the secondyear students of each field.

With the second-year students chosen as the base, the retention rates for all curricula are relatively steady with no alarming fluctuation or trend. In fact, regression analyses have been made for all data sets but no significant correlation with time is detected.

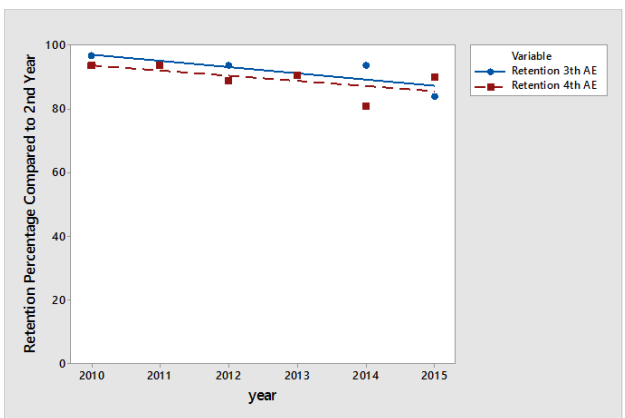

Fig.9 Retention rate of AE students with second-year students as the base.

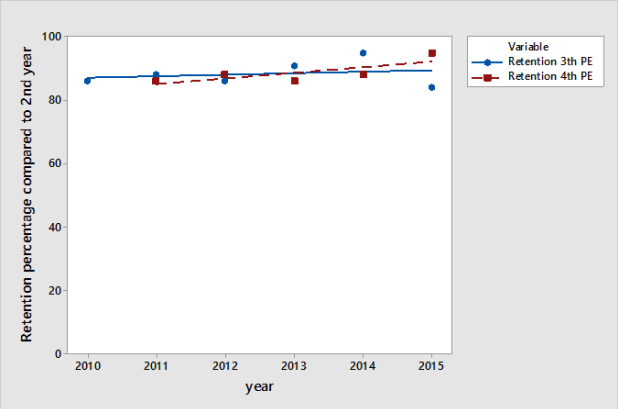

Fig.10 Retention rate of PE students with second-year students as the base.

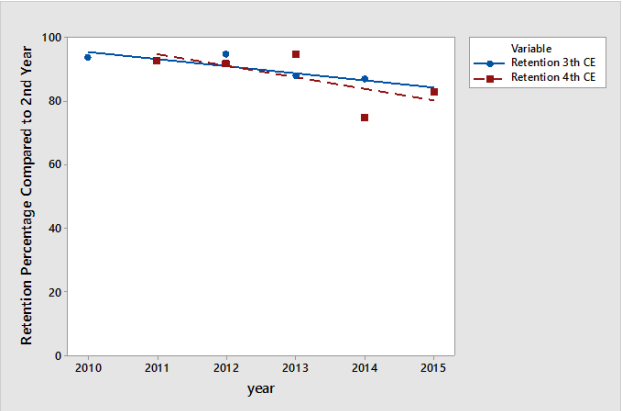

Fig.11 Retention rate of CE students with second-year students as the base.

IV. CONCLUSION

A statistical analysis software program is a very useful tool in decision making and its usage should not be limited to industries or commercial enterprises. Here, the software Minitab 17 is used to analyse students in the Faculty of Engineering, TNI. Results of the study clearly show that there is no correlation between the number of new students and the number of engineering curricula. Thus, a future decision to introduce a new engineering curriculum should be considered very carefully. Furthermore, the use of the program leads to a discovery of a clear decreasing trend in total students in one curriculum. If the result is taken to be a warning "flag", further analyses should be made and corrective actions, if deemed necessary, can be taken.

For the retention rate study, it is clear that the choice of the base is important. Different choices lead to different pictures. In this case, when the second-year students are chosen as the base, no alarming trend or correlation can be found. Therefore, any effort to improve the retention rate of a curriculum should be concentrated on retaining the second-year students of that field.

In conclusion, a statistical software program can be used to analyse and make decision concerning the numbers of students in engineering curricula. Further analyses of other factors relating to engineering students will be carried out in the future.

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