Efficiency Comparison of Two TCAS Minimum Mark Prediction Models: Top X% Model and Mean+N(s.d.) Model for Admission Round of TCAS in Year 2023

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Abstract

Thai university Central Admission System (TCAS) is developed for all high school students in Thailand. There are four rounds of TCAS called, portfolio, quota, admission and direct admission. The admission round is the round that use the mark of each test subject to compute the total mark, and then apply to TCAS. The minimum mark that can qualify the admission is the main point. However, the last year minimum mark cannot be used directly because of changing of subject combination, changing of fraction of the subject combination and the difficulty of the tests in each year. Otherwise, in year 2022, there are major changes in test subjects of TCAS. These lead to the prediction is more difficulty. The use of last year minimum marks directly is not efficient method because of its low accuracy. The researchers have developed two models called “Top X% model” and “Mean + N(s.d.) model” to predict the minimum mark. This paper represents the concept and methodology of each model, each model efficiency and compare their efficiency. The results show clearly that “Top X% model” is better than “Mean + N(s.d.) model” in term of model accuracy and error prediction average. The results also show that the prediction accuracy of “Top X% model” and “Mean + N(s.d.) model” for all four universities in year 2023 are 78.6744% and 75.5043%, respectively, with acceptance of the prediction total mark error not exceed 5%.

Keywords: TCAS Minimum Mark Prediction; Top X% Model; Mean + N(s.d.) Model; TCAS; Admission Round.

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1. Introduction

All high school students of Thailand can apply up to 10 majors for TCAS round 3 (Admission Round). After TCAS processing, one student will qualify only one major or disqualify. For this reason, the selection and sorting of ten majors for TCAS application is very important, that will be done with carefully planning. Each student knows only his/her total mark but not know the minimum mark that can qualify to his/her interesting major. The minimum mark to qualify the target major (may be called "predicted minimum mark") will be predicted by using two models called "Top X% model" and "Mean + N(s.d.) model". The early project used Top X% model (Ruethaichanok Kasatecharoen and Padungsak Kasatecharoen, 2023) to predict the minimum mark of high score majors in various universities with 88.73% accuracy where the error prediction not exceed 6%. Another prediction model called Mean + N(s.d.) (Ruethaichanok Kasatecharoen, Orawan Tunsui and Padungsak Kasatecharoen, 2023) is used to predict the minimum mark of moderate score majors for various universities, give 82.14% accuracy where the error prediction not exceed 6%. These results of the two models cannot be compared directly because the majors are not the same. The objective of this paper is to compare the efficiency of the two models at the same majors in term of the prediction error mean, the maximum prediction error, the minimum prediction error and the model accuracy.

The two models have the same concept which use the last year statistical data to predict the minimum mark of each major in the present year. The data of TCAS in year 2022 and 2023 of Chulalongkorn University (CU), Srinakharinwirot University (SWU), Thammasat University (TU) and Mahidol University (MU) are used to compute the predicted minimum mark of each major by using two models. The comparison of predicted minimum mark with "the real minimum mark", official announcement by TCAS after processing, is done. There are 135 majors of Chulalongkorn University in TCAS admission round in year 2022, but there are only 108 majors that have complete data for computation. Therefore, the computations are done completely for these 108 majors. The same computations are also done for 102 majors for Srinakharinwirot University, 109 majors for Thammasat University and 28 majors for Mahidol University.

2. Methods

2.1 TCAS processing and minimum mark prediction model concept

After Thai high school students take the TCAS examination in the mid of March. The results of the examination are officially announced by TCAS in mid of April. There are individual results for each student, each subject mark, each subject adjusted T-score mark and the test subjects' statistical data.

Frequency of the general subject score range year 2022 (edit on 30 April 2022)

Code	Subject	Number of people according to score range										Total
		0.000 - 10.000	10.001 - 20.000	20.001 - 30.000	30.001 - 40.000	40.001 - 50.000	50.001 - 60.000	60.001 - 700.000	70.001 - 80.000	80.001 - 90.000	90.001 - 100.000	
09	Thai	33	926	6,271	21,313	43,110	41,244	13,848	967	3	-	127,715
		0.026%	0.725%	4.910%	16.688%	33.755%	32.294%	10.843%	0.757%	0.002%	0.000%	
19	Social Study	120	4,886	23,788	41,730	35,675	15,892	3,188	218	3	-	125,500
		0.096%	3.893%	18.955%	33.251%	28.426%	12.663%	2.540%	0.174%	0.002%	0.000%	
29	English	212	18,386	52,429	30,860	17,173	10,209	5,338	1,247	31	-	135,885
		0.156%	13.531%	38.583%	22.710%	12.638%	7.513%	3.928%	0.918%	0.023%	0.000%	
39	Math 1	14,135	42,653	26,655	8,556	3,261	1,748	824	544	247	123	98,746
		14.315%	43.195%	26.993%	8.665%	3.302%	1.770%	0.834%	0.551%	0.250%	0.125%	
49	Physics	7,650	29,697	22,464	6,757	3,007	1,746	1,024	636	248	95	73,324
		10.433%	40.501%	30.637%	9.215%	4.101%	2.381%	1.397%	0.867%	0.338%	0.130%	
59	Chemistry	8,630	40,288	16,693	3,718	1,548	782	337	145	42	7	72,190
		11.955%	55.808%	23.124%	5.150%	2.144%	1.083%	0.467%	0.201%	0.058%	0.010%	
69	Biology	575	16,459	32,846	15,394	5,274	2,122	940	415	146	19	74,190
		0.775%	22.185%	44.273%	20.749%	7.109%	2.860%	1.267%	0.559%	0.197%	0.026%	
89	Math 2	1,430	5,368	4,765	1,759	835	347	171	92	46	23	14,836
		9.639%	36.182%	32.118%	11.856%	5.628%	2.339%	1.153%	0.620%	0.310%	0.155%	
99	General Science	649	5,112	8,162	4,726	1,706	237	58	16	1	-	20,667
		3.140%	24.735%	39.493%	22.867%	8.255%	1.147%	0.281%	0.077%	0.005%	0.000%	

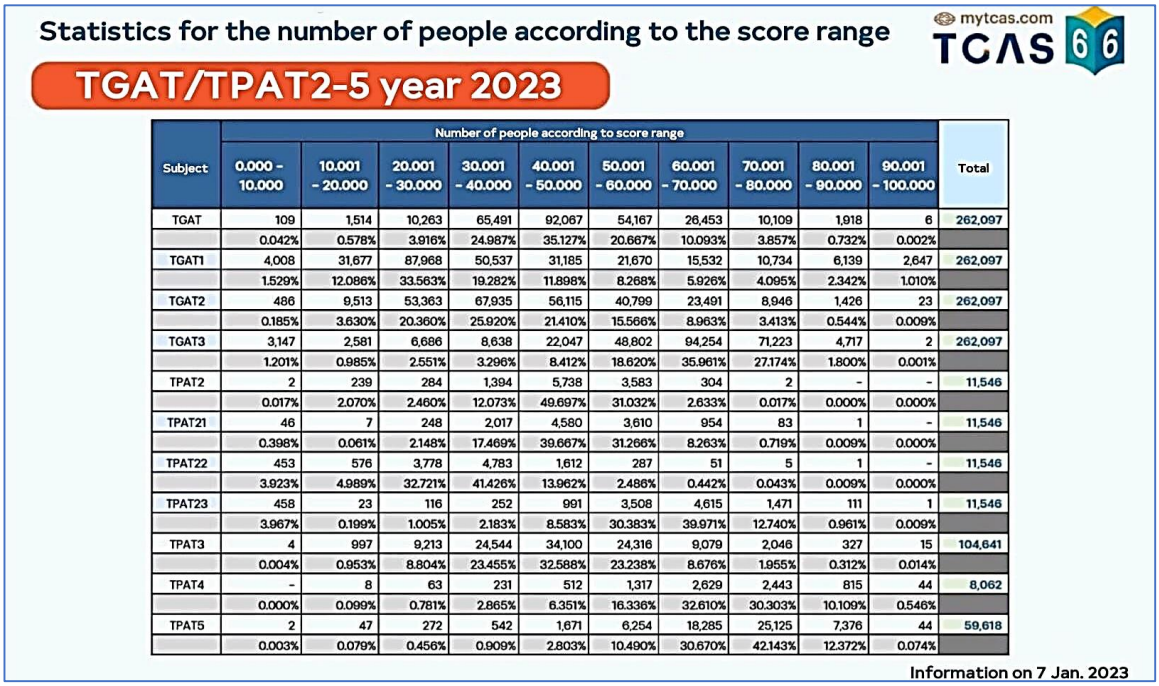
Figure 1 (a) mark distribution for each subject of year 2022

Basic statistics of GAT/PAT and general subject year 2022 (edit on 30 April 2022)

Code	Subject	Total	Number of examinees	Mean	Standard deviation (S.D.)	Min	Max	Mode	Median	Pearson Mode Skewness	Pearson Median Skewness
85	GAT General Aptitude Test	300.000	160,922	122.307	45.231	5.000	286.176	32.500	126.912	1.986	-0.305
	GAT (1)	150.000	160,767	78.744	35.112	0.000	150.000	111.706	86.647	-0.939	-0.675
	GAT (2)	150.000	160,915	43.640	16.974	0.000	147.500	37.500	40.000	0.362	0.643
71	PAT 1 Mathematics	300.000	108,987	61.140	35.304	0.000	300.000	42.000	54.000	0.542	0.607
72	PAT 2 Science	300.000	83,519	94.544	33.959	0.000	300.000	80.000	90.000	0.428	0.401
73	PAT 3 Engineering	300.000	21,319	96.007	29.109	28.000	262.000	80.000	88.000	0.550	0.825
74	PAT 4 Architecture	300.000	3,799	107.267	42.035	5.000	263.000	76.000	102.000	0.744	0.376
75	PAT 5 Teaching Profession	300.000	34,097	117.903	27.877	30.000	237.500	110.000	117.500	0.283	0.043
76	PAT 6 Fine Arts	300.000	4,871	114.732	24.111	42.500	216.000	111.500	114.000	0.134	0.091
77	PAT 7.1 French	300.000	3,158	112.871	58.302	33.000	300.000	78.000	90.000	0.598	1.177
78	PAT 7.2 German	300.000	852	112.345	51.999	42.000	285.000	90.000	93.000	0.430	1.116
79	PAT 7.3 Japanese	300.000	3,672	129.137	60.308	24.000	300.000	81.000	105.000	0.798	1.200
80	PAT 7.4 Chinese	300.000	7,470	108.245	50.007	30.000	300.000	84.000	90.000	0.485	1.095
81	PAT 7.5 Arabic	300.000	200	113.610	44.204	39.000	252.000	78.000	99.000	0.806	0.992
82	PAT 7.6 Pali	300.000	2,363	83.900	23.431	30.000	240.000	72.000	81.000	0.508	0.371
83	PAT 7.7 Korean	300.000	3,770	115.816	54.768	36.000	297.000	81.000	93.000	0.636	1.250
09	Thai	100.000	127,715	48.746	10.504	2.000	82.000	50.000	50.000	-0.119	-0.358
19	Social Study	100.000	125,500	39.502	10.945	4.000	82.000	40.000	40.000	0.046	-0.137
29	English	100.000	135,885	33.333	13.189	1.250	86.250	23.750	30.000	0.727	0.758
39	Math 1	100.000	98,746	21.027	12.473	0.000	100.000	15.000	18.000	0.483	0.728
49	Physics	100.000	73,324	22.889	13.418	0.000	100.000	15.000	20.000	0.588	0.646
59	Chemistry	100.000	72,190	19.606	9.699	0.000	98.000	16.000	18.000	0.372	0.497
69	Biology	100.000	74,190	28.914	11.232	0.000	96.000	24.000	26.000	0.438	0.778
89	Math 2	100.000	14,836	23.874	13.257	0.000	100.000	18.000	21.000	0.443	0.650
99	General Science	100.000	20,667	26.364	9.746	0.000	81.250	21.875	25.000	0.461	0.420

*PAT (Practical Aptitude Test)

Figure 1 (b) number of students and all statistical data such as mean, standard deviation(s.d.), min, max etc. of year 2022



Statistics for the number of people according to the score range

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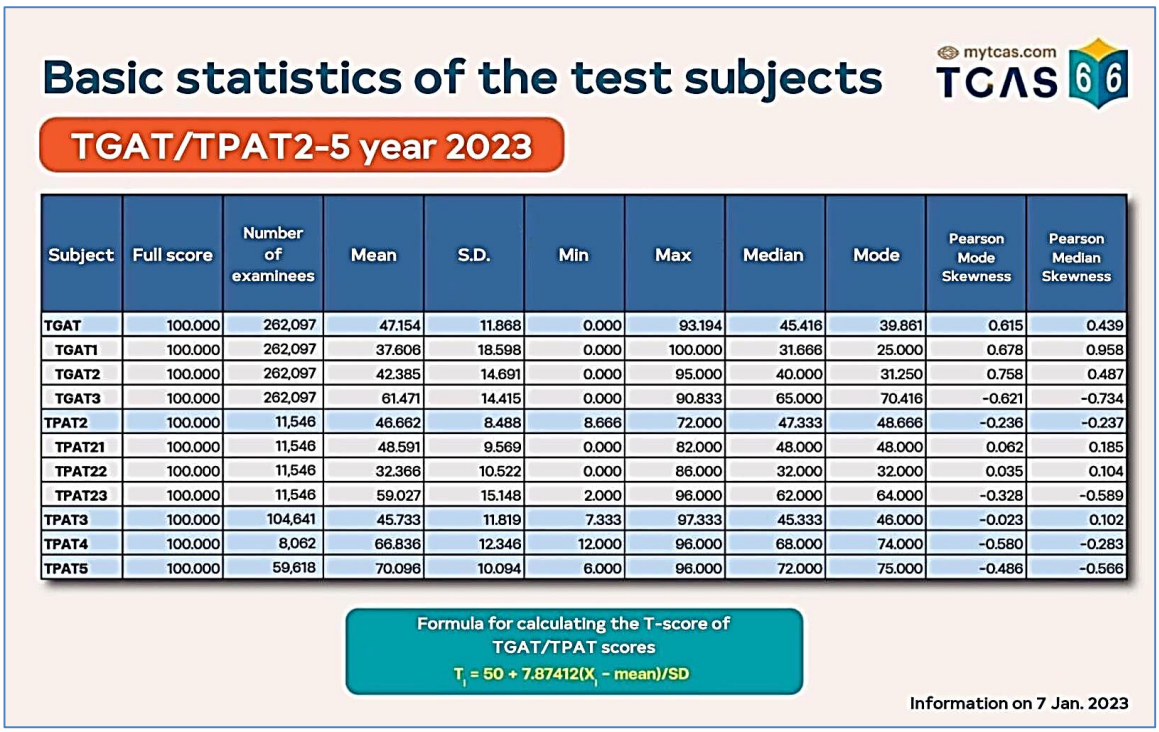
TGAT/TPAT2-5 year 2023

Subject	Number of people according to score range										Total
	0.000 – 10.000	10.001 – 20.000	20.001 – 30.000	30.001 – 40.000	40.001 – 50.000	50.001 – 60.000	60.001 – 70.000	70.001 – 80.000	80.001 – 90.000	90.001 – 100.000	
TGAT	109	1,514	10,263	65,491	92,067	54,167	26,453	10,109	1,918	6	262,097
	0.042%	0.578%	3.916%	24.987%	35.127%	20.667%	10.093%	3.857%	0.732%	0.002%	
TGAT1	4,008	31,677	87,968	50,537	31,185	21,670	15,532	10,734	6,139	2,647	262,097
	1.529%	12.086%	33.563%	19.282%	11.898%	8.268%	5.926%	4.095%	2.342%	1.010%	
TGAT2	486	9,513	53,363	67,935	56,115	40,799	23,491	8,946	1,426	23	262,097
	0.185%	3.630%	20.360%	25.920%	21.410%	15.566%	8.963%	3.413%	0.544%	0.009%	
TGAT3	3,147	2,581	6,686	8,638	22,047	48,802	94,254	71,223	4,717	2	262,097
	1.201%	0.985%	2.551%	3.296%	8.412%	18.620%	35.961%	27.174%	1.800%	0.001%	
TPAT2	2	239	284	1,394	5,738	3,583	304	2	-	-	11,546
	0.017%	2.070%	2.460%	12.073%	49.697%	31.032%	2.633%	0.017%	0.000%	0.000%	
TPAT21	46	7	248	2,017	4,580	3,610	954	83	1	-	11,546
	0.398%	0.061%	2.148%	17.469%	39.667%	31.266%	8.263%	0.719%	0.009%	0.000%	
TPAT22	453	576	3,778	4,783	1,612	287	51	5	1	-	11,546
	3.923%	4.989%	32.721%	41.426%	13.962%	2.486%	0.442%	0.043%	0.009%	0.000%	
TPAT23	458	23	116	252	991	3,508	4,615	1,471	111	1	11,546
	3.967%	0.199%	1.005%	2.183%	8.583%	30.383%	39.971%	12.740%	0.961%	0.009%	
TPAT3	4	997	9,213	24,544	34,100	24,316	9,079	2,046	327	15	104,641
	0.004%	0.953%	8.804%	23.455%	32.588%	23.238%	8.676%	1.955%	0.312%	0.014%	
TPAT4	-	8	63	231	512	1,317	2,629	2,443	815	44	8,062
	0.000%	0.099%	0.781%	2.865%	6.351%	16.336%	32.610%	30.303%	10.109%	0.546%	
TPAT5	2	47	272	542	1,671	6,254	18,285	25,125	7,376	44	59,618
	0.003%	0.079%	0.456%	0.909%	2.803%	10.490%	30.670%	42.143%	12.372%	0.074%	

Information on 7 Jan. 2023

Figure 2 (a) mark distribution for TGAT and TPAT subjects of year 2023



Basic statistics of the test subjects

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TGAT/TPAT2-5 year 2023

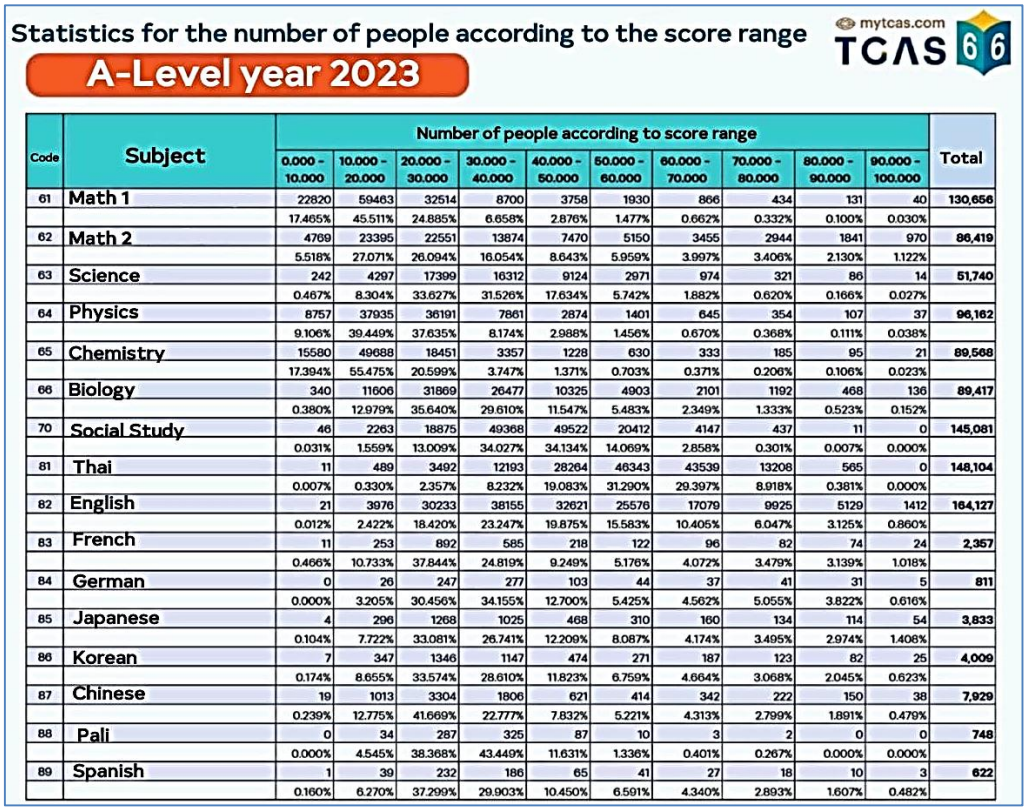
Subject	Full score	Number of examinees	Mean	S.D.	Min	Max	Median	Mode	Pearson Mode Skewness	Pearson Median Skewness
TGAT	100.000	262,097	47.154	11.868	0.000	93.194	45.416	39.861	0.615	0.439
TGAT1	100.000	262,097	37.606	18.598	0.000	100.000	31.666	25.000	0.678	0.958
TGAT2	100.000	262,097	42.385	14.691	0.000	95.000	40.000	31.250	0.758	0.487
TGAT3	100.000	262,097	61.471	14.415	0.000	90.833	65.000	70.416	-0.621	-0.734
TPAT2	100.000	11,546	46.662	8.488	8.666	72.000	47.333	48.666	-0.236	-0.237
TPAT21	100.000	11,546	48.591	9.569	0.000	82.000	48.000	48.000	0.062	0.185
TPAT22	100.000	11,546	32.366	10.522	0.000	86.000	32.000	32.000	0.035	0.104
TPAT23	100.000	11,546	59.027	15.148	2.000	96.000	62.000	64.000	-0.328	-0.589
TPAT3	100.000	104,641	45.733	11.819	7.333	97.333	45.333	46.000	-0.023	0.102
TPAT4	100.000	8,062	66.836	12.346	12.000	96.000	68.000	74.000	-0.580	-0.283
TPAT5	100.000	59,618	70.096	10.094	6.000	96.000	72.000	75.000	-0.486	-0.566

Formula for calculating the T-score of TGAT/TPAT scores

$T_i = 50 + 7.87412(X_i - \text{mean})/SD$

Information on 7 Jan. 2023

Figure 2 (b) number of students and all statistical data such as mean, standard deviation(s.d.), min, max etc. for TGAT and TPAT subjects of year 2023



Statistics for the number of people according to the score range

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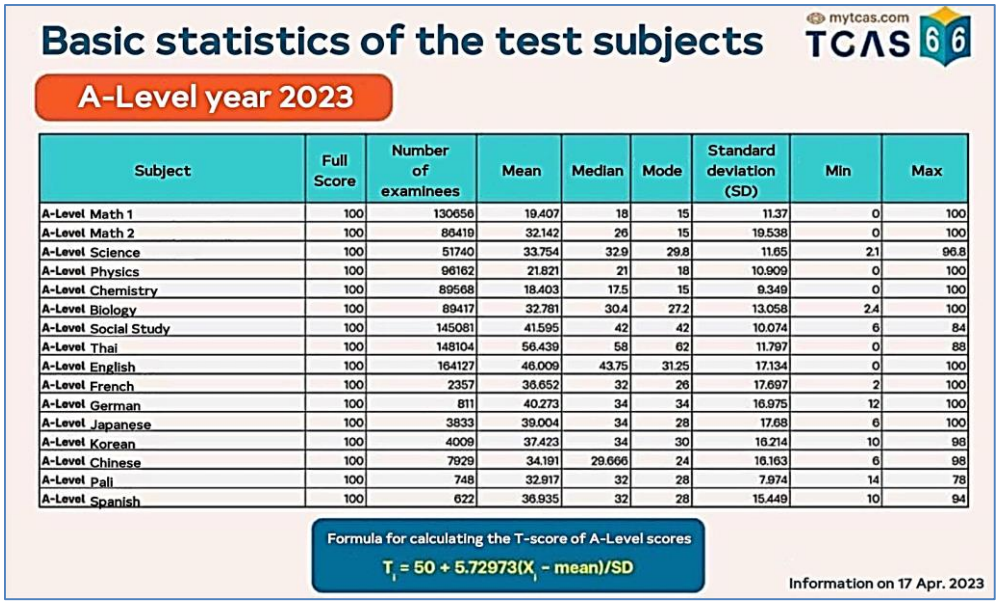
A-Level year 2023

Code	Subject	Number of people according to score range										Total
		0.000 - 10.000	10.000 - 20.000	20.000 - 30.000	30.000 - 40.000	40.000 - 50.000	50.000 - 60.000	60.000 - 70.000	70.000 - 80.000	80.000 - 90.000	90.000 - 100.000	
61	Math 1	22820	59463	32514	8700	3758	1930	866	434	131	40	130,656
		17.465%	45.511%	24.885%	6.658%	2.876%	1.477%	0.662%	0.332%	0.100%	0.030%	
62	Math 2	4769	23395	22551	13874	7470	5150	3455	2944	1841	970	86,419
		5.518%	27.071%	26.094%	16.054%	8.643%	5.959%	3.997%	3.406%	2.130%	1.122%	
63	Science	242	4297	17399	16312	9124	2971	974	321	86	14	51,740
		0.467%	8.304%	33.627%	31.526%	17.634%	5.742%	1.882%	0.620%	0.166%	0.027%	
64	Physics	8757	37935	36191	7861	2874	1401	645	354	107	37	96,162
		9.106%	39.449%	37.635%	8.174%	2.988%	1.456%	0.670%	0.368%	0.111%	0.038%	
65	Chemistry	15580	49688	18451	3357	1228	630	333	185	95	21	89,568
		17.394%	55.475%	20.599%	3.747%	1.371%	0.703%	0.371%	0.206%	0.106%	0.023%	
66	Biology	340	11606	31869	26477	10325	4903	2101	1192	468	136	89,417
		0.380%	12.979%	35.640%	29.610%	11.547%	5.483%	2.349%	1.333%	0.523%	0.152%	
70	Social Study	46	2263	18875	49368	49522	20412	4147	437	11	0	145,081
		0.031%	1.559%	13.009%	34.027%	34.134%	14.069%	2.858%	0.301%	0.007%	0.000%	
81	Thai	11	489	3492	12193	28264	46343	43539	13208	565	0	148,104
		0.007%	0.330%	2.357%	8.232%	19.083%	31.290%	29.397%	8.918%	0.381%	0.000%	
82	English	21	3976	30233	38155	32621	25576	17079	9925	5129	1412	164,127
		0.012%	2.422%	18.420%	23.247%	19.875%	15.583%	10.405%	6.047%	3.125%	0.860%	
83	French	11	253	892	585	218	122	96	82	74	24	2,357
		0.466%	10.733%	37.844%	24.819%	9.249%	5.176%	4.072%	3.479%	3.139%	1.018%	
84	German	0	26	247	277	103	44	37	41	31	5	811
		0.000%	3.205%	30.456%	34.155%	12.700%	5.425%	4.562%	5.055%	3.822%	0.616%	
85	Japanese	4	296	1268	1025	468	310	160	134	114	54	3,833
		0.104%	7.722%	33.081%	26.741%	12.209%	8.087%	4.174%	3.495%	2.974%	1.408%	
86	Korean	7	347	1346	1147	474	271	187	123	82	25	4,009
		0.174%	8.655%	33.574%	28.610%	11.823%	6.759%	4.664%	3.068%	2.045%	0.623%	
87	Chinese	19	1013	3304	1806	621	414	342	222	150	38	7,929
		0.239%	12.775%	41.669%	22.777%	7.832%	5.221%	4.313%	2.799%	1.891%	0.479%	
88	Pali	0	34	287	325	87	10	3	2	0	0	748
		0.000%	4.545%	38.368%	43.449%	11.631%	1.336%	0.401%	0.267%	0.000%	0.000%	
89	Spanish	1	39	232	186	65	41	27	18	10	3	622
		0.160%	6.270%	37.299%	29.903%	10.450%	6.591%	4.340%	2.893%	1.607%	0.482%	

Figure 2 (c) mark distribution for A-level subjects of year 2023



Basic statistics of the test subjects

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A-Level year 2023

Subject	Full Score	Number of examinees	Mean	Median	Mode	Standard deviation (SD)	Min	Max
A-Level Math 1	100	130656	19.407	18	15	11.37	0	100
A-Level Math 2	100	86419	32.142	26	15	19.538	0	100
A-Level Science	100	51740	33.754	32.9	29.8	11.65	2.1	96.8
A-Level Physics	100	96162	21.821	21	18	10.909	0	100
A-Level Chemistry	100	89568	18.403	17.5	15	9.349	0	100
A-Level Biology	100	89417	32.781	30.4	27.2	13.058	2.4	100
A-Level Social Study	100	145081	41.595	42	42	10.074	6	84
A-Level Thai	100	148104	56.439	58	62	11.797	0	88
A-Level English	100	164127	46.009	43.75	31.25	17.134	0	100
A-Level French	100	2357	36.652	32	26	17.697	2	100
A-Level German	100	811	40.273	34	34	16.975	12	100
A-Level Japanese	100	3833	39.004	34	28	17.68	6	100
A-Level Korean	100	4009	37.423	34	30	16.214	10	98
A-Level Chinese	100	7929	34.191	29.666	24	16.163	6	98
A-Level Pali	100	748	32.917	32	28	7.974	14	78
A-Level Spanish	100	622	36.935	32	28	15.449	10	94

Formula for calculating the T-score of A-Level scores

$T_i = 50 + 5.72973(X_i - \text{mean})/SD$

Information on 17 Apr. 2023

Figure 2 (d) number of students and all statistical data such as mean, standard deviation(s.d.), min, max etc. for A-level subjects of year 2023

Otherwise, the statistical data of all test subjects are also announced publicly as shown in Figure 1 to Figure 2 for year 2022 and 2023 respectively. The data shown in two figures are mark distribution for each subject, number of students and all statistical data such as mean, standard deviation(s.d.), min, max etc.

When the students know their test subject marks, the total mark of his or her interesting majors, apply to TCAS round 3, can be computed. The sum of each test subject weighed by specific fraction, announced by each major in TCAS website, is the total mark of the student individually. The students used these total marks to apply to TCAS, which allow each student can apply up to ten majors. After TCAS processing, the result is out only two ways, qualify only one major or disqualify. For this reason, the selection and sorting of ten majors for TCAS application is very important work, that will be done with carefully planning. The predicted minimum mark for each major is not only the ordinary number, but it's the heart of TCAS round 3. More accuracy of the predicted minimum mark, the great decision will be occurred.

From Figure 1 and 2, the difference of year 2022 and 2023, there are major change on TCAS test subjects such as GAT and PAT subjects change to TGAT and TPAT subject with full score change from 300 to 100. The subjects about languages such as English, France, German and Japanese have change from PAT group to A-level group with full score also change from 300 to 100. In this study, all subject marks and the statistical data of each test subject will use 100 full score base for computation.

The main concept of the minimum mark prediction models, represented in this paper, are used the last year statistical data, year 2022 in this case, to find the value of X for Top X% model and find the value N for mean + N(s.d.) model. Then the parameters, X and N, are used for minimum mark prediction in present year, year 2023 in this study.

The methodology of "Top X% model or X method" is using the mark distribution of the test subjects in year 2022 (Figure 1 (a)). Find the marks of each test subjects of the student who have total mark at the first X% of overall. The value of X will be satisfied the condition that the computed total mark of this major must be equal to or nearby the real total mark of the year 2022, officially announcement by TCAS. The acceptance of the difference value of computed total mark and the real total mark in year 2022 is set as +0.00% to +0.50%. Then the predicted minimum mark (X method) of the year 2023 is computed by using this X value and using the distribution data of year 2023 (Figure 2 (a) and Figure 2(b)). The same methodology is done for "mean + N(s.d.) model or N method". The difference from X method, the N method is using statistical data of the test subjects, mean and standard deviation (s.d.) for computation (data from Figure 1 (b) and Figure 2 (c) and Figure 2 (d)). The

value of N, satisfied the condition that makes the computed total mark of year 2022 must be equal to or nearby the real total mark of the year 2022 (the difference is set as +0.00% to +0.50%), is used for predicted total mark of year 2023 computation. Concept of two minimum mark prediction models shown in Figure 3.

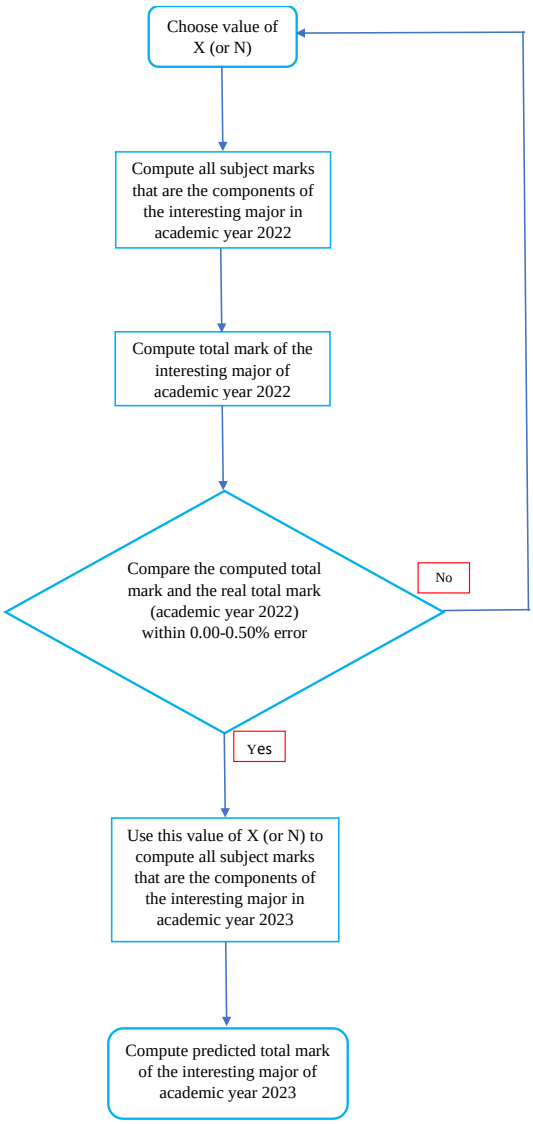

Figure 3 Concept of minimum mark prediction model of X method and N method

In this paper, the predicted total marks of 108 majors of Chulalongkorn University, 102 majors of Srinakharinwirot University, 109 majors of Thammasat University and 28 majors of Mahidol University

in year 2023 are computed. The computations of X method and N method for faculty of engineering (general engineering) Chulalongkorn University show below for example.

2.2 Example of predicted minimum mark computation of X method

In year 2022, the total mark of engineering major of Chulalongkorn University is the combination of three test subjects (the fraction in blanket), GAT (20%), PAT1 (20%) and PAT3 (60%). The minimum total mark of year 2022, officially announcement by TCAS, is 51.0196.

The value of X is found by trial-and-error method that satisfied X method condition. In this case, the value of X is found to be 6. The data of mark distribution of year 2022 are shown in Figure 1 (a). For GAT subject, use X=6 for computation, the first 6% of overall is 9,655 of 160,922 students. Now we find the mark of the student who is at the 9,655th. The computation of GAT mark at the 9,655th is 63.9817 of 100 full score (assumed linear equation in each mark interval). For PAT1 subject, have 108,987 students did the test, the first 6% is the 6,539th. The computation PAT1 mark at the 6,539th is 41.2992 of 100 full score. The same with the last combination, PAT3 subject, which have 21,319 students did this test. The 1,279th is the position of top 6%. The computation PAT3 mark at the 1,279th is 50.0516 of 100 full score.

Hence the computation of total mark of year 2022 with X=6, Computed Total Mark(2022 X6), can be shown as follow

Computed Total Mark(2022 X6) = 0.20 × 63.9817 + 0.20 × 41.2992 + 0.60 × 50.0516

Computed Total Mark(2022 X6) = 51.0871

This value is closed to the real minimum mark in year 2022, which is 51.0196 (+0.1323%). For this reason, X=6 is used to compute the predicted minimum mark of year 2023 by using the mark distribution in Figure 2. The total mark of this major in year 2023 is the combination of five subjects (the fraction in blanket), TGAT (20%), TPAT3 (30%), Mathematic1 (20%), Physics (20%) and Chemistry (10%). Do the same methodology, the computation TGAT mark of Top6% of TGAT test students, at the 15,725th of 262,097 students, is 68.6040. The computation of TPAT3 mark at the 6,278th of 104,641 students is 65.7149. The computed Mathematic1 mark is 39.2180 (at the 7,839th of 130,656 students), 39.5526 (at the 5,769th of 96,162 students) for Physics subject and 31.4147 (at the 5,374th of 89,568 students) for Chemistry subject.

Hence, the computation of total mark of year 2023 with X=6, represented as Predicted Minimum Mark(2023 X6), can be computed as follow

Predicted Minimum Mark (2023 X 6) = 0.20 × 68.6040 + 0.30 × 65.7149 + 0.20 × 39.2180 + 0.20 × 39.5526 + 0.10 × 31.4147

Predicted Minimum Mark (2023 X 6) = 52.3309

Comparison of Predicted Minimum Mark (2023 X 6) and the real minimum mark 54.1500, officially announced by TCAS, shows the error = 52.3309 – 54.1500 = -1.8191. The minus sign shows the prediction value is less than real value and the value shows the accuracy of the model on this major.

2.3 Example of predicted minimum mark computation of N method

The statistical data, mean and standard deviation (s.d.), in year 2022 are shown in Figure 1 (b). N method is using these two statistical data to compute the test subject marks that make the total mark equal or nearby the value of officially minimum mark. In this example, Engineering major of Chulalongkorn University, the value of N is found by trial-and-error method that is found to be 1.77 which satisfied N method condition. Therefore N=1.77 is used. The computation of GAT mark is shown as follow

GAT = mean of GAT + 1.77 × (s.d.of GAT)

GAT = (122.507 + 1.77 × 45.231) × 100 / 300 = 66.2753 of 100 full score

The computation of other two subjects with using N=1.77 are PAT1 = 41.2094 of 100 full score and PAT3 = 49.1766 of 100 full score

Hence the computation of total mark of year 2022 with N=1.77, represented as Computed Total Mark(2022 N1.77), can be shown as follow

Computed Total Mark (2022 N1.77) = 0.20 × 66.2753 + 0.20 × 41.2094 + 0.60 × 49.1766

Computed Total Mark (2022 N1.77) = 51.0029

This value is nearby the real minimum mark in year 2022, which is 51.0196 (+0.0327%). For this reason, N=1.77 is used to compute test subjects in year 2023 by using the statistical data in Figure 2. The computations show below.

TGAT= 47.154 + 1.77 × 11.868 = 68.1604 of 100 full score

TPAT3 = 45.733 + 1.77 × 11.819 = 66.6526 of 100 full score

Mathematic1 = 19.407 + 1.77 × 11.370 = 39.5319 of 100 full score

Physics = 21.821 + 1.77 × 10.909 = 41.1299 of 100 full score

Chemistry = 18.403 + 1.77 × 9.349 = 34.9507 of 100 full score

Hence, the computation of total mark of year 2023 with N= 1.77, represented as Predicted Minimum Mark (2023 N1.77) can be computed as follow

Predicted Minimum Mark (2023 N1.77) = 0.20 × 68.1604 + 0.30 × 66.6526 + 0.20 × 39.5319
+ 0.20 × 41.1299 + 0.10 × 34.9507

Predicted Minimum Mark (2023 N1.77) = 53.2553

Comparison of Predicted Minimum Mark (2023 N1.77) and the real minimum mark 54.1500, officially announced by TCAS, shows the error = 53.2553 – 54.1500 = -0.8947. The minus sign shows the prediction value is less than real value and the value shows the accuracy of the model on this major. It is clearly seen that N method is more accuracy than X method in this major because of less prediction error.

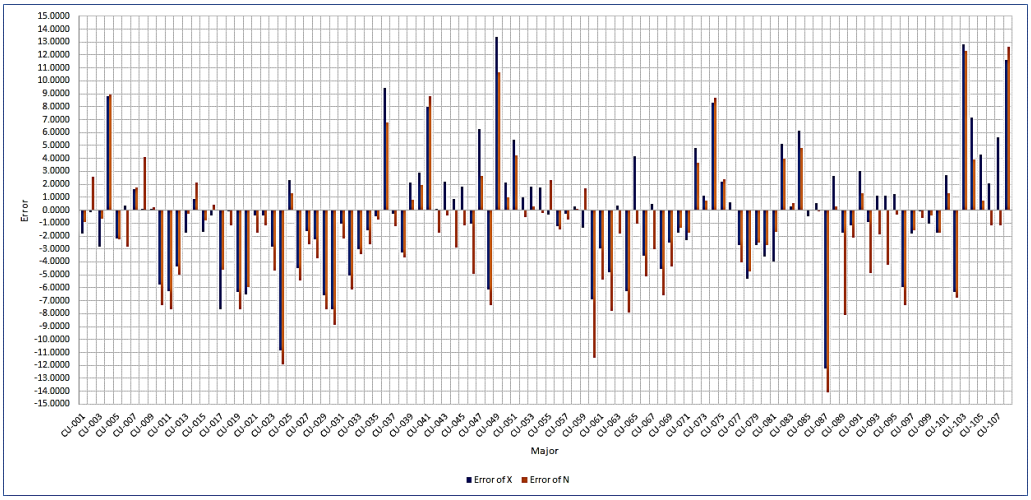

Figure 4 Minimum mark prediction error of 108 majors of Chulalongkorn University using X method and N method prediction in year 2023

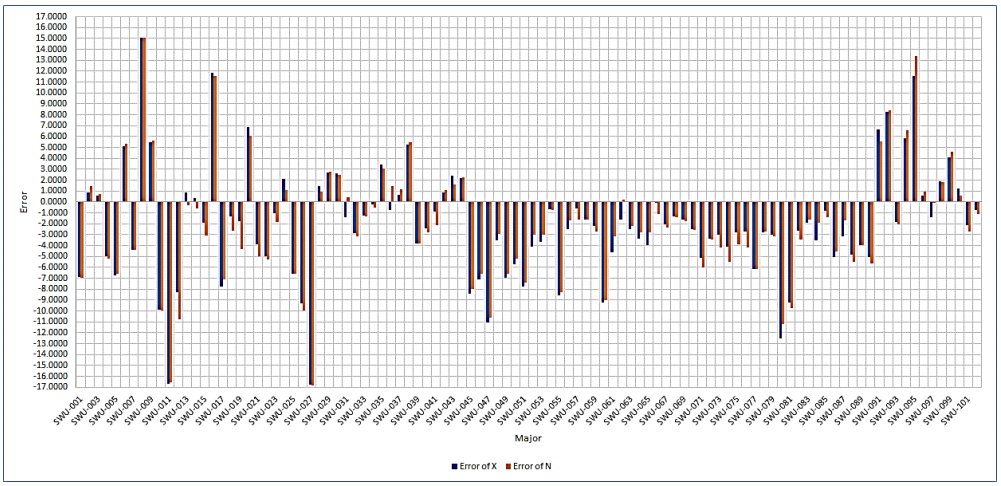

Figure 5 Minimum mark prediction error of 102 majors of Srinakharinwirot University using X method and N method prediction in year 2023

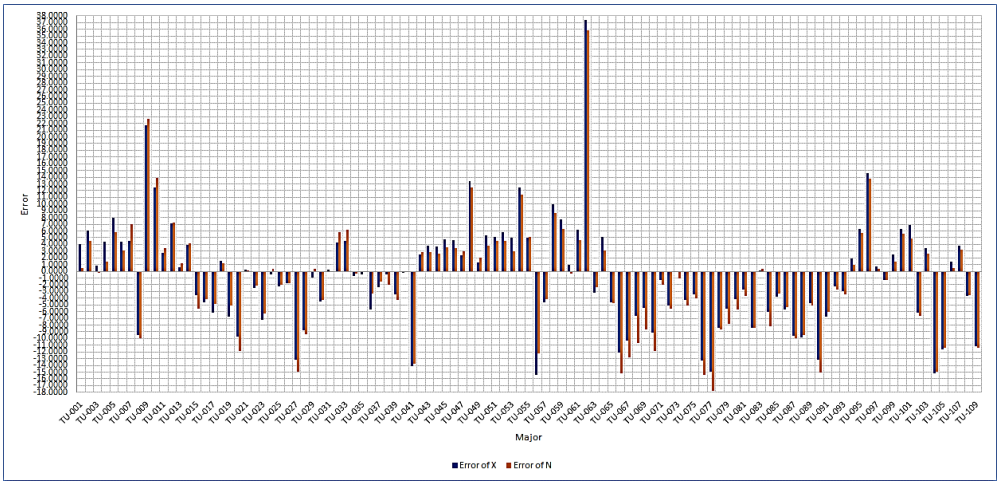

Figure 6 Minimum mark prediction error of 109 majors of Thammasat University using X method and N method prediction in year 2023

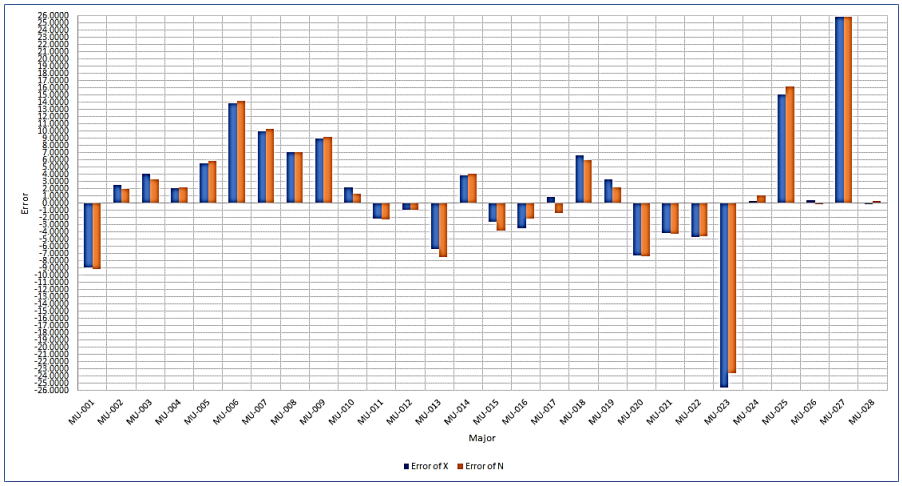

Figure 7 Minimum mark prediction error of 28 majors of Mahidol University using X method and N method prediction in year 2023

3. Results and Discussion

The results of the minimum mark prediction error of 108 majors of Chulalongkorn University, 102 majors of Srinakharinwirot University, 109 majors of Thammasat University and 28 majors of Mahidol University, computation using X method and N method, are shown by graph in Figure 4, Figure 5, Figure 6 and Figure 7 respectively. The graphs show that the error between prediction marks by two models are in the same trend.

The efficiency of each model can be considered from the error statistical data and the error prediction distribution. The error prediction statistical data of Chulalongkorn University,

Srinakharinwirot University, Thammasat University and Mahidol University for X method and N method model are shown in Figure 8. The error, using last year minimum mark (TCAS2022 method), are also shown in the table. It is clearly seen that X method have all statistical data better than N method, especially the mean of error of X method is only -0.3147 but this value is -1.3499 for N method for Chulalongkorn University. However, in case of Srinakharinwirot University, two error means from two method are the closed values which are -2.0957 and -2.1572. For Thammasat University, the error mean of X method and N method are -0.7635 and -1.2987 respectively. These two values are 1.6522 and 1.5834 for Mahidol University respectively. Otherwise, from Figure 8, it can be concluded that both X method and N method can be used for minimum mark prediction exactly better than TCAS2022 method. In case of Mahidol university, even though TCAS2022 method seems to be less error (-0.8519), the X method error (1.6522) and N method error (1.5834) are preferred caused of practical used in application sorting decision.

The prediction error distribution of X method, N method and TCAS2022 method of the four universities which are Chulalongkorn University, Srinakharinwirot University, Thammasat University and Mahidol University are shown in Figure 9. From Figure 9, it is clearly seen that X method is better model than N method. If the error not exceed -5% is acceptance, X method have 78.6744% accuracy, however, N method have only 75.5043% accuracy (green highlights). However, if the student use last year minimum mark (TCAS2022 method) for planning, the accuracy will be only 36.0231%.

For easier to comparison of X and N prediction method, Figure 10 shows the accuracy difference between these two prediction models of the four universities (yellow highlights). The results show clearly that X method is exactly better than N method for the four universities of interest.

	Chulalongkorn Univeristy (108 majors)			Srisakharinwirot Univeristy (102 majors)		
Statistical data of prediction error	X method	N method	TCAS2022 method	X method	N method	TCAS2022 method
minimum	-12.2623	-14.0727	-29.0452	-16.7356	-16.7965	-48.0408
maximum	13.4139	12.6256	14.3951	15.1016	15.0541	7.9963
mean	-0.3147	-1.3499	-8.1889	-2.0957	-2.1572	-12.2130
satandard deviation (s.d.)	4.5388	4.6546	9.5013	5.1800	5.2244	9.8490
	Thammasat Univeristy (109 majors)			Mahidol Univeristy (28 majors)		
Statistical data of prediction error	X method	N method	TCAS2022 method	X method	N method	TCAS2022 method
minimum	-15.4350	-17.8160	-35.4162	-25.5635	-23.5464	-25.4500
maximum	37.3978	35.8529	26.7949	25.8218	25.8487	39.5387
mean	-0.7635	-1.2987	-8.8652	1.6522	1.5834	-0.8519
satandard deviation (s.d.)	7.8959	7.9667	10.6930	9.1521	9.0946	11.6123

Figure 8 Error prediction statistical data of Chulalongkorn University, Srinakharinwirot University, Thammasat University and Mahidol University for X method and N method model and last year minimum mark method (TCAS2022 method) in year 2023.

X method				
Error interval	Number of majors	Number of major accumulation	%	% Accumulation
greater or equal 10.0000	15	15	4.3228	4.3228
from 9.0000 and 9.9999	4	19	1.1527	5.4755
from 8.0000 and 8.9999	3	22	0.8646	6.3401
from 7.0000 and 7.9999	6	28	1.7291	8.0692
from 6.0000 and 6.9999	10	38	2.8818	10.9510
from 5.0000 and 5.9999	13	51	3.7464	14.6974
from 4.0000 and 4.9999	14	65	4.0346	18.7320
from 3.0000 and 3.9999	9	74	2.5937	21.3256
from 2.0000 and 2.9999	21	95	6.0519	27.3775
from 1.0000 and 1.9999	15	110	4.3228	31.7003
from 0.0000 and 0.9999	30	140	8.6455	40.3458
form -0.9999 to 0.0000	29	169	8.3573	48.7032
form -1.9999 to -1.0000	31	200	8.9337	57.6369
form -2.9999 to -2.0000	31	231	8.9337	66.5706
form -3.9999 to -3.0000	22	253	6.3401	72.9107
form -4.9999 to -4.0000	20	273	5.7637	78.6744
form -5.9999 to -5.0000	13	286	3.7464	82.4207
form -6.9999 to -6.0000	20	306	5.7637	88.1844
form -7.9999 to -7.0000	7	313	2.0173	90.2017
from -8.9999 to -8.0000	7	320	2.0173	92.2190
from -9.9999 to -9.0000	9	329	2.5937	94.8127
smaller or equal -10.0000	18	347	5.1873	100.0000
Total	347		100.0000	

N method				
Error interval	Number of majors	Number of major accumulation	%	% Accumulation
greater or equal 10.0000	16	16	4.6110	4.6110
from 9.0000 and 9.9999	1	17	0.2882	4.8991
from 8.0000 and 8.9999	5	22	1.4409	6.3401
from 7.0000 and 7.9999	3	25	0.8646	7.2046
from 6.0000 and 6.9999	6	31	1.7291	8.9337
from 5.0000 and 5.9999	10	41	2.8818	11.8156
from 4.0000 and 4.9999	11	52	3.1700	14.9856
from 3.0000 and 3.9999	13	65	3.7464	18.7320
from 2.0000 and 2.9999	16	81	4.6110	23.3429
from 1.0000 and 1.9999	21	102	6.0519	29.3948
from 0.0000 and 0.9999	26	128	7.4928	36.8876
form -0.9999 to 0.0000	26	154	7.4928	44.3804
form -1.9999 to -1.0000	36	190	10.3746	54.7550
form -2.9999 to -2.0000	29	219	8.3573	63.1124
form -3.9999 to -3.0000	21	240	6.0519	69.1643
form -4.9999 to -4.0000	22	262	6.3401	75.5043
form -5.9999 to -5.0000	20	282	5.7637	81.2680
form -6.9999 to -6.0000	12	294	3.4582	84.7262
form -7.9999 to -7.0000	14	308	4.0346	88.7608
from -8.9999 to -8.0000	7	315	2.0173	90.7781
from -9.9999 to -9.0000	8	323	2.3055	93.0836
smaller or equal -10.0000	24	347	6.9164	100.0000
Total	347		100.0000	

Figure 9 The prediction error distribution of X method, N method and TCAS2022 method of four universities in year 2023

4. Conclusion

This study aims to compare the efficiency of TCAS minimum mark prediction between X method and N method. The predicted minimum mark of 108 majors of Chulalongkorn University, 102 majors of Srinakharinwirot University, 109 majors of Thammasat University and 28 majors of Mahidol University in year 2023 are computed. Then, researchers compare the predicted minimum marks and the real minimum marks, officially announced by TCAS after processing. The results can be concluded that X method, Top X% model, is better than N method, Mean + N(s.d.) model in case of -5% error acceptance. However, the comparison in this study will be continued on year 2024 with

also various majors and universities. Furthermore, the computer program may be used to find the value of X and N for work fast and better computation.

Error interval	% Accumulation of X method	% Accumulation of N method	Accuracy diffence of X-N
greater or equal 10.0000	4.3228	4.6110	-0.2882
from 9.0000 and 9.9999	5.4755	4.8991	0.5764
from 8.0000 and 8.9999	6.3401	6.3401	0.0000
from 7.0000 and 7.9999	8.0692	7.2046	0.8646
from 6.0000 and 6.9999	10.9510	8.9337	2.0173
from 5.0000 and 5.9999	14.6974	11.8156	2.8818
from 4.0000 and 4.9999	18.7320	14.9856	3.7464
from 3.0000 and 3.9999	21.3256	18.7320	2.5937
from 2.0000 and 2.9999	27.3775	23.3429	4.0346
from 1.0000 and 1.9999	31.7003	29.3948	2.3055
from 0.0000 and 0.9999	40.3458	36.8876	3.4582
form -0.9999 to 0.0000	48.7032	44.3804	4.3228
form -1.9999 to -1.0000	57.6369	54.7550	2.8818
form -2.9999 to -2.0000	66.5706	63.1124	3.4582
form -3.9999 to -3.0000	72.9107	69.1643	3.7464
form -4.9999 to -4.0000	78.6744	75.5043	3.1700
form -5.9999 to -5.0000	82.4207	81.2680	1.1527
form -6.9999 to -6.0000	88.1844	84.7262	3.4582
form -7.9999 to -7.0000	90.2017	88.7608	1.4409
from -8.9999 to -8.0000	92.2190	90.7781	1.4409
from -9.9999 to -9.0000	94.8127	93.0836	1.7291
smaller or equal -10.0000	100.0000	100.0000	0.0000

Figure 10 Accuracy difference between X and N prediction method of four universities in year 2023

5. Acknowledgement

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