第 48 卷 第 9 期
2021 年 9 月

湖南大学学报（自然科学版）
Journal of Hunan University（Natural Sciences）

Vol. 48. No. 9.
September 2021

Open Access Article

Management Information Technology for Depression Strategies during COVID-19 Using by Data Mining Technique

Kanakarn Phanniphong[1], Pratya Nuankaew[2*]

[1] Rajamangala University of Technology Tawan-ok, Chakrabongse Bhuvanath campus, Bangkok, 10400, Thailand

[2] School of Information and Communication Technology, University of Phayao, Phayao, Thailand

Abstract: The impact of the COVID-19 pandemic in universities profoundly influences the quality of learners' education. Thus, the research goals were to examine attitudes to the impact of the COVID-19 pandemic in universities and to study the influencing effects on college students' depression. The scientific novelty was the integration of artificial intelligence technology to manage education in the COVID-19 pandemic proactively. The research sample consisted of 2,624 students from ten faculties and one institution. Basic statistics and data mining techniques are used in the analysis of research. It consists of frequency, mean, percentage, standard deviation, k-Means, k-Determination. The results of the study revealed that the students had a severe attitude towards the COVID-19 epidemic situation. The impact that students are most concerned about is the online learning management process. In addition, the overall opinion of the respondents had a high level of anxiety about learning management. In addition, the data-mining analysis showed that it was consistent with most normal levels of depression, anxiety, and stress among students. In future research, the researcher plans to develop an application program to support organization management with modern technology and to prepare students for the future of learning.

Keywords: management information technology, data mining, depression strategies, COVID-19.

新冠肺炎期間抑鬱症策略的管理信息技術使用數據挖掘技術

摘要：新冠肺炎 大流行對大學的影響深刻地影響了學習者的教育質量。因此，研究目標是檢查對大學中新冠肺炎大流行影響的態度，並研究對大學生抑鬱症的影響。科學創新是整合人工智能技術來主動管理新冠肺炎大流行中的教育。研究樣本包括來自十個學院和一個機構的 2,624 名學生。基本統計和數據挖掘技術用於研究分析。它由頻率、平均值、百分比、標準偏差、k 均值、k-確定組成。研究結果顯示，學生們對新冠肺炎疫情的態度較為嚴峻。學生最關心的影響是在線學習管理過程。此外，受訪者的總體意見對學習管理的焦慮程度較高。此外，數據挖掘分析表明，這與學生的抑鬱、焦慮和壓力的大多數正常水平一致。在未來的研究中，研究人員計劃開發一個應用程序，以支持現代技術的組織管理，並為學生的未來學習做好準備。

关键词：管理信息技术、数据挖掘、抑郁策略、新冠肺炎。

1. Introduction

The impact of COVID-19 is not only affecting the health system and the economic system, but it has a severe impact on the education system and students at institutions of all learning levels. Numerous research reports reflect the problems posed by the COVID-19 pandemic on the education system for broader learners [1]–[3]. International policies, visions, and strategies

Received: May 1, 2021 / Revised: June 6, 2021 / Accepted: August 26, 2021 / Published: September 30, 2021

Fund Project: Thailand Science Research and Innovation Fund and the University of Phayao (Grant No. FF64-UoE004)

About the authors: Kanakarn Phanniphong, Rajamangala University of Technology Tawan-ok, Bangkok, Thailand; Pratya Nuankaew, School of Information and Communication Technology, University of Phayao, Phayao, Thailand

Corresponding author Pratya Nuankaew, pratya.nu@up.ac.th

are used to solve problems. No matter how much effort there is, being prepared and monitoring the problem is imperative. For Thailand, problems from the Covid-19 pandemic situation affect youth developing knowledge and learning in the education system, including within schools, universities, and educational institutions. The next effect is mental health disease. Many students are at risk for depression. Studies and research on depression in Thailand reflect the growing severity of future problems in Thailand [4], [5], [13], [14].

Based on such importance and necessity, this research has two main objectives: (1) to examine attitudes to the impact of the COVID-19 pandemic in universities and (2) to study the influencing effects on college students' depression. This research combines quantitative and qualitative research using statistical techniques and data mining techniques, which are technologies that reflect problems and can effectively search for the knowledge contained within data. Scope of the research: the researchers determine that students studying for a bachelor's degree are from Rajamangala University of Technology Tawan-ok. The research sample consisted of 2,624 students from the Faculty Agro-Industrial Technology (AGRO), the Faculty of Agriculture and Natural Resource (AGRI), the Faculty of Business Administration and Information Technology (BUSIT), the Faculty of Engineering and Architecture (ENAR), the Faculty of Humanities and Social Sciences (HUSO), the Faculty of Liberal Arts (LA), the Faculty of Science and Technology (SCIENCE), the Faculty of Social Technologies (SOCIAL), the Faculty of Veterinary Medicine (VET), the Institute of Aviation Technology (IAT), and the School of Engineering and Innovation (SEI). Data collection details are presented in Table 4 to Table 7.

Finally, the researchers are firmly convinced that this research is appropriate and necessary for the organization and Thailand, which the researchers hope to bring this research to develop in the future. The overall outline of the research consisted of the following: The first part is to clarify the importance and origin of the research problem. The second part reviews the relevant literature and related works, the third part is a research methodology, and the fourth part is research results. The fifth part is the research discussion. Finally, the last part is the conclusion.

2. Literature Review

There is much research to find the factors of solving the problem of COVID-19 [1]–[8]. A prime example is Nuankaew's research [1]. They study the impact of COVID-19 in terms of attitudes towards online learning from the effect of coronavirus 2019 disease on university students in Thailand. Their findings show their attitudes towards the impact of COVID-19 by using data mining techniques for analysis. They were able to create a predictive model of attitudes towards the development factors of the student's university learning process.

Another research is Abuhammad's work [3]. He presents the barriers to distance learning during the COVID-19 outbreak as a qualitative review from parents' perspectives. He discovered the four main elements, the eleven sub-elements of the COVID-19 barriers to distance learning: (1) personal barriers including lack of training and support, lack of technical expertise, inadequate communication, and lack of qualifications, (2) technical barriers including insufficient investment and maintenance, (3) logistical barriers including difficulties in using distance learning and lack of students preparation, and dissatisfaction with distance learning modality, and the inability of distance learning to meet students' needs, and (4) financial barriers including the inability to buy technology, and inability to pay for internet services. These reflect the problems of promoting and managing distance learning for learners. However, researchers are focusing on improving quality of life as part of this research aimed at tackling COVID-19 and the risk of depression.

3. Research Methodology

The research process uses analytical principles based on data mining techniques for research control and development. It is known as CRISP-DM: Cross-Industry Standard Process for Data Mining [9], [10]. There are six phases of CRISP-DM process: business understanding, data understanding, data preparation, modeling, evaluation, and deployment.

3.1. Business Understanding

The Business Understanding (BU) phase is an important step in starting the research process. It is responsible for finding and setting research goals [10]. The goals of this research consist of two main objectives: (1) to examine attitudes to the impact of the COVID-19 pandemic in universities and (2) to study the influencing effects on college students' depression.

For the first objective, the researchers used an online questionnaire to collect attitudes and the impact of the COVID-19 pandemic, as detailed in Table 1. It has three impact dimensions of twelve questions: (1) impact dimension of learning and learning management, (2) impact dimension of economic, society, and daily life, and (3) impact dimension of personal relationship. There are four levels of impact feedback threshold: 1 means no impact, 2 means less impact, 3 means moderate impact, and 4 means high impact.

Table 1 Impact of the COVID-19 pandemic on university students

Impact Dimension	Impact Level				Comment
	1	2	3	4	
D1: Dimension of Learning and Learning Management					
D1-1: Opening/Closing of the Semester					

Impact Dimension	Impact Level 1	2	3	4	Comment
D1-2: Online Learning Management Process					
D1-3: Material for Online Learning					
D1-4: Accessibility for Online Learning Systems					
D1-5: Impact on Learning					
D2: Dimension of Economics, Society, and Daily Life					
D2-1: Transport Safety					
D2-2: Welfare					
D2-3: Activities on Campus					
D2-4: Daily Lifestyle					
D2-5: Government Preventive Measures					
D3: Dimension of Personal Relationship					
D3-1: Relationship of Friend					
D3-2: Relationship of Family					

For the second objective, the researchers compiled data to analyze the relationship and influence of the COVID-19 pandemic on depression risk as detailed in the online questionnaire in Table 2. The rating scale is as follows: 0 means did not apply to me at all, 1 means applied to me to some degree, or some of the time, 2 means applied to me to a considerable degree or a good part of the time, and 3 means applied to me very much or most of the time.

Table 2 Depression risk analysis questions

No	Questions	Impact Level 1	2	3	4
1 (s)	I found it hard to wind down				
2 (a)	I was aware of the dryness of my mouth				
3 (d)	I could not seem to experience any positive feeling at all				
4 (a)	I experienced breathing difficulty				
5 (d)	I found it difficult to work up the initiative to do things				
6 (s)	I tended to over-react to situations				
7 (a)	I experienced trembling				
8 (s)	I felt that I was using much nervous energy				
9 (a)	I was worried about situations in which I might panic and make a fool of myself				
10 (d)	I felt that I had nothing to look forward to				
11 (s)	I found myself getting agitated				
12 (s)	I found it difficult to relax				
13 (d)	I felt downhearted and blue				
14 (s)	I was intolerant of anything that kept me from getting on with what I was doing				
15 (a)	I felt I was close to panic				
16 (d)	I was unable to become enthusiastic about anything				
17 (d)	I felt I was not worth much as a person				
18 (s)	I felt that I was rather touchy				
19 (a)	I was aware of the action of my heart in the absence of physical exertion				
20 (a)	I felt scared without any good reason				
21 (d)	I felt that life was meaningless				

Table 2 is an analytical questionnaire. It is known as DASS-21: Depression, Anxiety and Stress Scale with 21 Items [11]. It is a set of three self-report scales designed to measure the emotional states of depression, anxiety, and stress. The analysis results are calculated and interpreted as shown in Table 3.

Table 3 Interpretation of analysis results

Category	Depression	Anxiety	Stress
Normal	0 - 9	0 - 7	0 - 14
Mild	10 - 13	8 - 9	15 - 18
Moderate	14 - 20	10 - 14	19 - 25
Severe	21 - 27	15 - 19	26 - 33
Extremely Severe	28+	20+	34+

3.2. Data Understanding

Data Understanding (DU) phase is the process of understanding the data to be collected. After understanding the issues and problems of the research, it is important to understand it to prepare the data for the next step [9], [10].

For this research, the DU phase was an important step in the preparation of data collection. The researchers plan data collection to cover the research population. It is required to collect data from students of all faculties in Rajamangala University of Technology Tawan-ok, which comprises ten faculties one institution including the Faculty Agro-Industrial Technology (AGRO), the Faculty of Agriculture and Natural Resource (AGRI), the Faculty of Business Administration and Information Technology (BUSIT), the Faculty of Engineering and Architecture (ENAR), the Faculty of Humanities and Social Sciences (HUSO), the Faculty of Liberal Arts (LA), the Faculty of Science and Technology (SCIENCE), the Faculty of Social Technologies (SOCIAL), the Faculty of Veterinary Medicine (VET), the Institute of Aviation Technology (IAT), and the School of Engineering and Innovation (SEI).

Rajamangala University of Technology Tawan-ok student information is shown by affiliation and program, as shown in Table 4. In addition, the collected data are summarized in Table 5. Moreover, it is prepared for analysis and prototype development in the data preparation stage.

3.3. Data Preparation

Data Preparation (DP) phase is the process of preparing data for analysis to develop prototypes [9], [10]. In this step, the researchers collect the data, clean the data, and organize the data model ready for analysis to create the model. The data prepared to develop the model is gathered from the data understanding (DU) phase. It is presented in two tables: Table 4 shows the research population, and Table 5 shows the collected data.

Table 4 Research population

Faculty/Institution	Nep	Ns
Faculty Agro-Industrial Technology (AGRO)	14 (15.22%)	835 (10.91%)
Faculty of Agriculture and Natural Resource (AGRI)	10 (10.87%)	415 (5.42%)
Faculty of Business Administration and Information Technology (BUSIT)	19 (20.65%)	2,172 (28.37%)
Faculty of Engineering and Architecture (ENAR)	13 (14.13%)	731 (9.55%)
Faculty of Humanities and Social Sciences (HUSO)	10 (10.87%)	1,098 (14.34%)
Faculty of Liberal Arts (LA)	4 (4.35%)	400 (5.22%)

Faculty/Institution	Nep	Ns
Faculty of Science and Technology (SCIENCE)	6 (6.52%)	363 (4.74%)
Faculty of Social Technologies (SOCIAL)	7 (7.61%)	709 (9.26%)
Faculty of Veterinary Medicine (VET)	2 (2.17%)	251 (3.28%)
Institute of Aviation Technology (IAT)	3 (3.26%)	272 (3.55%)
School of Engineering and Innovation (SEI)	4 (4.35%)	411 (5.37%)
Total:	92 (100%)	7,657 (100%)

Note: Nep = Number of Educational Programs, Ns = Number of Students

Table 4 shows the research population. It consists of 10 faculties, one institute, and 92 educational programs. Table 4 shows that the Faculty of Business Administration and Information Technology (BUSIT) has the largest number of students with 2,172 students (28.37%) and the largest number of educational programs with 19 educational programs (20.65%). While in second place, the Faculty of Humanities and Social Sciences (HUSO) has a total enrolment of 1,098 students (14.34%) and has 10 educational programs (10.87%). These data were analyzed to collect research data. The researchers collected data distributed to all faculties and institutions, summarized in Table 5.

Table 5 Data collection

Faculty/Institution	Nc	Percentage
Faculty Agro-Industrial Technology (AGRO)	313	11.93%
Faculty of Agriculture and Natural Resource (AGRI)	118	4.50%
Faculty of Business Administration and Information Technology (BUSIT)	606	23.09%
Faculty of Engineering and Architecture (ENAR)	350	13.34%
Faculty of Humanities and Social Sciences (HUSO)	412	15.70%
Faculty of Liberal Arts (LA)	141	5.37%
Faculty of Science and Technology (SCIENCE)	66	2.52%
Faculty of Social Technologies (SOCIAL)	264	10.06%
Faculty of Veterinary Medicine (VET)	62	2.36%
Institute of Aviation Technology (IAT)	81	3.09%
School of Engineering and Innovation (SEI)	211	8.04%
Total:	2,624	100.00%

Note: Nc = number of data collection

Table 5 shows the data collection according to which the Faculty of Business Administration and Information Technology (BUSIT) has the largest number of data collection with 606 students (23.09%), the second is the Faculty of Humanities and Social Sciences (HUSO) with 412 students (15.70%), the third is the Faculty of Engineering and Architecture (ENAR) with 350 students (13.34%). These data are made available for prototype development and published on the Internet: https://bit.ly/3wkMB9E.

3.4. Modeling

The modeling (M) phase is the process of analyzing data to create models for research and utilization [9], [10]. The research modeling process uses unsupervised learning data mining tools. It is known as k-Means Clustering. The working principle of k-Means is the grouping of similar data behavior. It uses the cluster mean to represent the group's representative value. It is known as centroid.

The centroid value will calculate the new members who have entered the system for further use in management. The model development and analysis results are described in detail and presented in Tables 11-19 and Figs. 1-3 in the following sections.

3.5. Evaluation

The evaluation (E) phase is the testing process to find an appropriate and effective model [10]. In determining the appropriate model in this research, the researchers use the elbow methods to determine the appropriate k-value. It is known as k-Determination [12]. Its working principle is to determine the average within centroid distance value as it changes from vertical to horizontal axis or changes from horizontal to the vertical axis. Once the appropriate k values are obtained, the centroid can be calculated, and the cluster members are efficiently distributed.

3.6. Deployment

The deployment (D) phase is an efficient and useful model implementation process [9], [10]. The use of research results needs to be developed in an easy-to-use format. It makes it necessary for researchers to continue to study and develop research into an application or package program that is convenient to use, suitable for information users, administrators, and other stakeholders. It is the goal of the next research.

Equations should be written clearly, uniformly numbered, and accompanied by the necessary information. They should also be separated from the main text.

4. Research Results

4.1. The Data Collection Report

The scope of this research data is student data from Rajamangala University of Technology Tawan-ok comprising ten faculties, one institution from ninety-two academic programs, as detailed in Tables 1-5. The collected data were analyzed and presented in various dimensions, as shown in Tables 6-10.

Table 6 Analyzed by gender and affiliation

Faculty/Institution	Gender		Total
	Male	Female	
Faculty Agro-Industrial Technology (AGRO)	127 (40.58%)	186 (59.42%)	313 (11.93%)
Faculty of Agriculture and	46	72	118

Faculty/Institution	Gender		Total
	Male	Female	
Natural Resource (AGRI)	(38.98%)	(61.02%)	(4.50%)
Faculty of Business Administration and Information Technology (BUSIT)	255 (42.08%)	351 (57.92%)	606 (23.09%)
Faculty of Engineering and Architecture (ENAR)	308 (88.00%)	42 (12.00%)	350 (13.34%)
Faculty of Humanities and Social Sciences (HUSO)	89 (21.60%)	323 (78.40%)	412 (15.70%)
Faculty of Liberal Arts (LA)	36 (25.53%)	105 (74.47%)	141 (5.37%)
Faculty of Science and Technology (SCIENCE)	28 (42.42%)	38 (57.58%)	66 (2.52%)
Faculty of Social Technologies (SOCIAL)	68 (25.76%)	196 (74.24%)	264 (10.06%)
Faculty of Veterinary Medicine (VET)	11 (17.74%)	51 (82.26%)	62 (2.36%)
Institute of Aviation Technology (IAT)	9 (11.11%)	72 (88.89%)	81 (3.09%)
School of Engineering and Innovation (SEI)	164 (77.73%)	47 (22.27%)	211 (8.04%)
Total:	874 (33.31%)	1,750 (66.69%)	2,624 (100%)

Table 6 shows that the collected data were analyzed by gender and affiliation. It found that the samples collected were more females (1,750 samples; 66.69%) than males (874 samples; 33.31%).

Table 7 Analyzed by academic year and affiliation

Affiliation	Academic Year					Total
	Year 1	Year 2	Year 3	Year 4	Year 5	
AGRO	38 (12.14%)	73 (23.32%)	102 (32.59%)	92 (29.39%)	8 (2.56%)	313 (11.93%)
AGRI	27 (22.88%)	21 (17.80%)	31 (26.27%)	28 (23.73%)	11 (9.32%)	118 (4.50%)
BUSIT	86 (14.19%)	138 (22.77%)	196 (32.34%)	169 (27.89%)	17 (2.81%)	606 (23.09%)
ENAR	48 (13.71%)	114 (32.57%)	67 (19.14%)	115 (32.86%)	6 (1.71%)	350 (13.34%)
HUSO	74 (17.96%)	117 (28.40%)	108 (26.21%)	104 (25.24%)	9 (2.18%)	412 (15.70%)
LA	23 (16.31%)	44 (31.21%)	22 (15.60%)	42 (29.79%)	10 (7.09%)	141 (5.37%)
SCIENCE	17 (25.76%)	20 (30.30%)	13 (19.70%)	5 (7.58%)	11 (16.67%)	66 (2.52%)
SOCIAL	42 (15.91%)	48 (18.18%)	83 (31.44%)	83 (31.44%)	8 (3.03%)	264 (10.06%)
VET	19 (30.6%)	13 (21.0%)	4 (6.5%)	25 (40.3%)	1 (1.6%)	62 (2.36%)
IAT	16 (19.75%)	18 (22.22%)	30 (37.04%)	15 (18.52%)	2 (2.47%)	81 (3.09%)
SEI	31 (14.69%)	77 (36.49%)	62 (29.38%)	34 (16.11%)	7 (3.32%)	211 (8.04%)
Total:	421 (16.04%)	683 (26.03%)	718 (27.36%)	712 (27.13%)	90 (3.43%)	2,624 (100%)

Table 7 shows the collected data was analyzed by academic year and affiliation. It was found that the sample collected had the highest number of 718 (27.36%) third-year students. The second is Year 4, with 712 samples (27.13%), the third -Year 2, with 683 samples (26.03%), the fourth- Year 1, with 421 samples (16.04%), and the last - Year 5, with 90 samples (3.43%).

Table 8 The impact of the COVID-19 (1)

Impact	Affiliation					
	AGRO	AGRI	BUSIT	ENAR	HUSO	LA
D1: Dimension of Learning and Learning Management						
D1-1	3.04: High Impact	2.82: High Impact	2.94: High Impact	2.92: High Impact	2.95: High Impact	2.83: High Impact
D1-2	3.32: High Impact	3.23: High Impact	3.31: Highest Impact	3.37: Highest Impact	3.31: Highest Impact	3.16: High Impact
D1-3	3.01: High Impact	2.82: High Impact	2.92: High Impact	2.93: High Impact	2.95: High Impact	2.85: High Impact
D1-4	2.99: High Impact	2.86: High Impact	2.88: High Impact	2.95: High Impact	2.89: High Impact	2.84: High Impact
D1-5	3.33: Highest Impact	3.22: High Impact	3.31: Highest Impact	3.28: Highest Impact	3.28: Highest Impact	3.11: High Impact
D2: Dimension of Economics, Society, and Daily Life						
D2-1	2.57: High Impact	2.69: High Impact	2.59: High Impact	2.79: High Impact	2.65: High Impact	2.72: High Impact
D2-2	2.58: High Impact	2.59: High Impact	2.64: High Impact	2.72: High Impact	2.63: High Impact	2.75: High Impact
D2-3	3.00: High Impact	3.14: High Impact	3.03: High Impact	2.96: High Impact	2.95: High Impact	3.01: High Impact
D2-4	2.79: High	2.90: High	2.78: High	2.86: High	2.77: High	2.76: High
D2-5	2.95: High Impact	2.94: High Impact	2.97: High Impact	2.88: High Impact	2.97: High Impact	2.99: High Impact
D3: Dimension of Personal Relationship						
D3-1	2.31: Moderate Impact	2.30: Moderate Impact	2.22: Moderate Impact	2.03: Moderate Impact	2.10: Moderate Impact	2.02: Moderate Impact
D3-2	2.04: Moderate Impact	2.03: Moderate Impact	1.95: Moderate Impact	1.76: Moderate Impact	1.95: Moderate Impact	1.92: Moderate Impact
Average	2.83: High Impact	2.80: High Impact	2.80: High Impact	2.68: High Impact	2.78: High Impact	2.75: High Impact

Table 9 The impact of the COVID-19 (2)

Impact	Affiliation					
	SCI	SOC	VET	IAT	SEI	Average
D1: Dimension of Learning and Learning Management						
D1-1	2.61: High Impact	2.91: High Impact	3.10: High Impact	3.32: Highest Impact	2.72: High Impact	2.93: High Impact
D1-2	3.23: High Impact	3.20: High Impact	2.23: High Impact	3.33: Highest Impact	3.09: High Impact	3.27: Highest Impact
D1-3	2.74: High Impact	2.88: High Impact	2.82: High Impact	3.05: High Impact	2.71: High Impact	2.91: High Impact
D1-4	2.80: High Impact	2.83: High Impact	2.77: High Impact	2.96: High Impact	2.70: High Impact	2.88: High Impact
D1-5	3.09: High Impact	3.21: High Impact	3.18: High Impact	3.38: Highest Impact	3.10: High Impact	3.25: Highest Impact
D2: Dimension of Economics, Society, and Daily Life						
D2-1	2.58: High Impact	2.70: High Impact	2.74: High Impact	2.94: High Impact	2.61: High Impact	2.66: High Impact
D2-2	2.64: High Impact	2.69: High Impact	2.68: High Impact	2.91: High Impact	2.65: High Impact	2.66: High Impact
D2-3	3.09:	2.95:	3.00:	3.24:	3.00:	3.01:

Impact	Affiliation					
	SCI	SOC	VET	IAT	SEI	Average
	High Impact	High Impact	High Impact	High Impact	High Impact	High Impact
D2-4	2.82: High Impact	2.84: High Impact	2.94: High Impact	3.14: High Impact	2.66: High Impact	2.81: High Impact
D2-5	3.23: High Impact	2.96: High Impact	3.02: High Impact	3.17: High Impact	2.87: High Impact	2.96: High Impact
D3: Dimension of Personal Relationship						
D3-1	1.88: Moderate Impact	2.10: Moderate Impact	2.21: Moderate Impact	2.47: Moderate Impact	2.05: Moderate Impact	2.15: Moderate Impact
D3-2	1.89: Moderate Impact	1.87: Moderate Impact	1.84: Moderate Impact	1.98: Moderate Impact	1.84: Moderate Impact	1.92: Moderate Impact
Average	2.72: High Impact	2.76: High Impact	2.71: High Impact	2.99: High Impact	2.67: High Impact	2.78: High Impact

Table 8 and Table 9 show that the collected data were analyzed to determine the impact of the COVID-19. It found that, as a whole, students were affected by the high level of the COVID-19 situation. The most severe impact on the learners was D1-2: the online learning management process; the second – D1-5: impact on learning; the third – D2-3: Activities on Campus. It can be seen that the impact affects the learning of future learners. In addition, Table 10 shows the results of an analysis of depression risk.

Table 10 Depression risk analysis

Affiliation/depression risk analysis/sample/percentage			
Faculty Agro-Industrial Technology (AGRO)			
Category	**Depression**	**Anxiety**	**Stress**
Normal	263 (84.03%)	278 (88.82%)	305 (97.44%)
Mild	27 (8.63%)	6 (1.92%)	5 (1.60%)
Moderate	20 (6.39%)	24 (7.67%)	3 (0.96%)
Severe	3 (0.96%)	2 (0.64%)	0
Extremely Severe	0	3 (0.96%)	0
Faculty of Agriculture and Natural Resource (AGRI)			
Category	**Depression**	**Anxiety**	**Stress**
Normal	104 (88.14%)	102 (86.44%)	112 (94.92%)
Mild	3 (2.54%)	5 (4.24%)	2 (1.69%)
Moderate	10 (8.47%)	8 (6.78%)	4 (3.39%)
Severe	1 (0.85%)	1 (0.85%)	0
Extremely Severe	0	2 (1.69%)	0
Faculty of Business Administration and Information Technology (BUSIT)			
Category	**Depression**	**Anxiety**	**Stress**
Normal	535 (88.28%)	550 (90.76%)	578 (95.38%)
Mild	41 (6.77%)	16 (2.64%)	22 (3.63%)
Moderate	26 (4.29%)	34 (5.61%)	6 (0.99%)
Severe	4 (0.66%)	5 (0.83%)	0
Extremely Severe	0	1 (0.17%)	0
Faculty of Engineering and Architecture (ENAR)			
Category	**Depression**	**Anxiety**	**Stress**
Normal	306 (87.43%)	308 (88.00%)	338 (96.57%)
Mild	26 (7.43%)	16 (4.57%)	9 (2.57%)
Moderate	18 (5.14%)	25 (7.14%)	3 (0.86%)
Severe	0	1 (0.29%)	0
Extremely Severe	0	0	0
Faculty of Humanities and Social Sciences (HUSO)			
Category	**Depression**	**Anxiety**	**Stress**
Normal	375 (91.02%)	370 (89.81%)	402 (97.57%)
Mild	20 (4.85%)	19 (4.61%)	8 (1.94%)
Affiliation/depression risk analysis/sample/percentage			
Moderate	16 (3.88%)	19 (4.61%)	2 (0.49%)
Severe	1 (0.24%)	3 (0.73%)	0
Extremely Severe	0	1 (0.24%)	0
Faculty of Liberal Arts (LA)			
Category	**Depression**	**Anxiety**	**Stress**
Normal	131 (92.91%)	132 (93.62%)	138 (97.87%)
Mild	4 (2.84%)	4 (2.84%)	3 (2.13%)
Moderate	6 (4.26%)	4 (2.84%)	0
Severe	0	1 (0.71%)	0
Extremely Severe	0	0	0
Faculty of Science and Technology (SCIENCE)			
Category	**Depression**	**Anxiety**	**Stress**
Normal	60 (90.91%)	57 (86.36%)	64 (96.97%)
Mild	2 (3.03%)	2 (3.03%)	1 (1.52%)
Moderate	4 (6.06%)	7 (10.61%)	1 (1.52%)
Severe	0	0	0
Extremely Severe	0	0	0
Faculty of Social Technology (SOCIAL)			
Category	**Depression**	**Anxiety**	**Stress**
Normal	233 (88.26%)	239 (90.53%)	255 (96.59%)
Mild	20 (7.58%)	8 (3.03%)	8 (3.03%)
Moderate	10 (3.79%)	14 (5.30%)	1 (0.38%)
Severe	1 (0.38%)	2 (0.76%)	0
Extremely Severe	0	0	0
Faculty of Veterinary Medicine (VET)			
Category	**Depression**	**Anxiety**	**Stress**
Normal	57 (91.94%)	58 (93.55%)	62 (100.00%)
Mild	4 (6.45%)	1 (1.61%)	0
Moderate	1 (1.61%)	3 (4.84%)	0
Severe	0	0	0
Extremely Severe	0	0	0
Institute of Aviation Technology (IAT)			
Category	**Depression**	**Anxiety**	**Stress**
Normal	75 (92.59%)	74 (91.36%)	80 (98.77%)
Mild	3 (3.70%)	1 (1.23%)	1 (1.23%)
Moderate	3 (3.70%)	6 (7.41%)	0
Severe	0	0	0
Extremely Severe	0	0	0
School of Engineering and Innovation (SEI)			
Category	**Depression**	**Anxiety**	**Stress**
Normal	177 (83.89%)	185 (87.68%)	206 (97.63%)
Mild	16 (7.58%)	7 (3.32%)	2 (0.95%)
Moderate	15 (7.11%)	16 (7.58%)	3 (1.42%)
Severe	3 (1.42%)	2 (0.95%)	0
Extremely Severe	0	1 (0.47%)	0
Overall summary of the analysis			
Category	**Depression**	**Anxiety**	**Stress**
Normal	2,316 (88.26%)	2,353 (89.67%)	2,540 (96.80%)
Mild	166 (6.33%)	85 (3.24%)	61 (2.32%)
Moderate	129 (4.92%)	160 (6.10%)	23 (0.88%)
Severe	13 (0.50%)	17 (0.65%)	0
Extremely Severe	0	9 (0.34%)	0

Table 10 shows the depression risk analysis at Rajamangala University of Technology Tawan-ok. It was found that, as a whole, university students had no problems with depression which status is normal (2,316 samples: 88.26%). It corresponded to the state of

anxiety and stress among university students, which were normal. However, when considering the opposite, it was found that about 11 percent of university students had to be monitored. The dimension that most students focus on is the anxiety dimension about the Covid-19 situation. It was reflected in the data were analyzed with a moderate level of anxiety with the highest number of 160 samples (6.10%) and appear more concerned with the extremely severe number of 9 samples (0.34%).

Based on these findings, the researchers extracted and scoped data to analyze the depressive, anxiety, and stress risk clustering as a model, presented in the next section.

4.2. The Model Development Report

The models developed in these sections are the depression risk clustering model, the anxiety risk clustering model, and the stress risk clustering model. The summaries of this section consist of finding the appropriate number of clusters and summarizing the appropriate centroid values.

4.2.1. Depression Risk Clustering Model

The depression risk clustering model was reported in three phases: report the optimal k value, report the cluster's centroid, and report the member of each cluster. All details are presented and reported in Fig. 1 and Table 11 to Table 13.

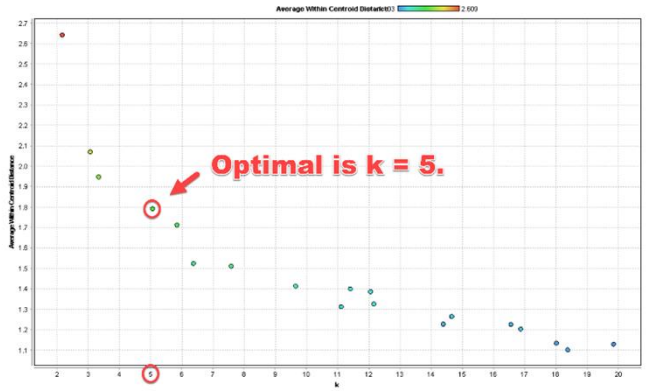

Fig. 1 Optimal k-value for depression risk clustering model

Fig. 1 shows the analysis for selecting the appropriate k-value. It can be concluded that the k-value should be used to create a suitable cluster is k equal to 5 as detailed in Table 11, the centroid of each cluster is shown in Table 12, and the members summary is reported in Table 13.

Table 11 k-value and average within centroid distance (ACD)

k	ACD	k	ACD	k	ACD
2	2.609	8	1.548	14	1.259
3	2.100	9	1.436	15	1.195
4	1.954	10	1.395	16	1.204
5	1.768	11	1.303	17	1.231
6	1.709	12	1.336	18	1.145
7	1.548	13	1.369	19	1.149

Note: ACD = Average within Centroid Distance

Table 12 The centroid of each cluster

Attribute	Centroid				
	D1	D2	D3	D4	D5
3 (d)	0.64	0.18	1.05	2.14	2.32
5 (d)	0.90	0.24	1.30	2.12	1.22
10 (d)	0.76	0.08	1.85	2.25	0.77
13 (d)	0.80	0.10	1.52	2.23	0.95
16 (d)	0.93	0.15	1.60	2.21	0.92
17 (d)	0.33	0.02	0.99	2.10	0.42
21 (d)	0.24	0.02	0.78	2.12	0.27

Table 12 shows the centroid of each cluster. It shows the distribution of each attribute. In addition, the example and overall distributions of the member data analyzed are presented in Table 13.

Table 13 Member summary report

Affiliation	Member				
	D1	D2	D3	D4	D5
AGRO	68 (21.73%)	153 (48.88%)	32 (10.22%)	27 (8.63%)	33 (10.54%)
AGRI	30 (25.42%)	54 (45.76%)	8 (6.78%)	11 (9.32%)	15 (12.71%)
BUSIT	175 (28.88%)	277 (45.71%)	48 (7.92%)	40 (6.60%)	66 (10.89%)
ENAR	96 (27.43%)	162 (46.29%)	40 (11.43%)	22 (6.29%)	30 (8.57%)
HUSO	108 (26.21%)	219 (53.16%)	34 (8.25%)	22 (5.34%)	29 (7.04%)
LA	41 (29.08%)	69 (48.94%)	18 (12.77%)	8 (5.67%)	5 (3.55%)
SCIENCE	17 (25.76%)	33 (50.00%)	5 (7.58%)	5 (7.58%)	6 (9.09%)
SOCIAL	89 (33.71%)	109 (41.29%)	33 (12.50%)	15 (5.68%)	18 (6.82%)
VET	22 (35.48%)	27 (43.55%)	8 (12.90%)	1 (1.61%)	4 (6.45%)
IAT	28 (34.57%)	39 (48.15%)	2 (2.47%)	5 (6.17%)	7 (8.64%)
SEI	49 (23.22%)	89 (42.18%)	34 (16.11%)	21 (9.95%)	18 (8.53%)
Total:	723 (27.55%)	1,231 (46.91%)	262 (9.98%)	177 (6.75%)	231 (8.80%)

Table 13 shows the members in each cluster classified by affiliation. It found that the 2nd cluster had the most members with 1,231 samples (46.91%). The second group with the largest number of members is the 1st cluster with 723 samples (27.55%), The third group is the 3rd cluster with 262 samples (9.98%), The fourth group is the 5th cluster with 231 samples (8.80%), and the last group is the 4th cluster with 177 samples (6.75%).

4.2.2. Anxiety Risk Clustering Model

The anxiety risk clustering model was reported in three phases: report the optimal k value, report the cluster's centroid, and report the member of each cluster. All details are presented and reported in Fig. 2 and Tables 14-16.

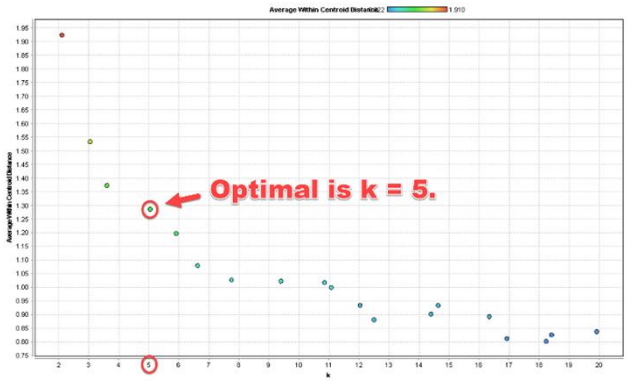

Fig. 2 Optimal k-value for anxiety risk clustering model

Fig. 2 shows the analysis for selecting the appropriate k-value. It can be concluded that the k-value should be used to create a suitable cluster is k equal to 5 as detailed in Table 14, the centroid of each cluster is shown in Table 15, and the members summary is reported in Table 16.

Table 14 k-value and average within centroid distance (ACD)

k	ACD	k	ACD	k	ACD
2	1.910	8	1.044	14	0.900
3	1.547	9	1.034	15	0.921
4	1.376	10	1.016	16	0.884
5	1.276	11	0.996	17	0.825
6	1.196	12	0.913	18	0.822
7	1.090	13	0.901	19	0.833

Note: ACD = Average within Centroid Distance

Table 15 Centroid of each cluster

Attribute	Centroid				
	A1	A2	A3	A4	A5
2 (a)	0.11	2.24	1.87	0.50	0.63
4 (a)	0.02	0.50	1.82	0.36	0.34
7 (a)	0.04	0.39	1.95	0.43	0.54
9 (a)	0.20	1.21	1.99	1.22	1.76
15 (a)	0.08	0.58	1.85	0.71	1.57
19 (a)	0.08	0.54	1.92	0.69	1.22
20 (a)	0.09	0.55	1.85	0.67	2.05

Table 15 shows the centroid of each cluster. It shows the distribution of each attribute. In addition, the example and overall distributions of the member data analyzed are presented in Table 16.

Table 16 Member summary report

Affiliation	Member				
	A1	A2	A3	A4	A5
AGRO	193 (61.66%)	14 (4.47%)	27 (8.63%)	65 (20.77%)	14 (4.47%)
AGRI	70 (59.32%)	6 (5.08%)	11 (9.32%)	29 (24.58%)	2 (1.69%)
BUSIT	394 (65.02%)	25 (4.13%)	30 (4.95%)	131 (21.62%)	26 (4.29%)
ENAR	213 (60.86%)	20 (5.71%)	19 (5.43%)	82 (23.43%)	16 (4.57%)
HUSO	270 (65.53%)	25 (6.07%)	20 (4.85%)	83 (20.15%)	14 (3.40%)
LA	96 (68.09%)	6 (4.26%)	4 (2.84%)	33 (23.40%)	2 (1.42%)
SCIENCE	44 (66.67%)	0	5 (7.58%)	13 (19.70%)	4 (6.06%)
SOCIAL	159 (60.23%)	8 (3.03%)	16 (6.06%)	69 (26.14%)	12 (4.55%)
VET	31 (50.00%)	3 (4.84%)	3 (4.84%)	22 (35.48%)	3 (4.84%)
IAT	56 (69.14%)	3 (3.70%)	5 (6.17%)	15 (18.52%)	2 (2.47%)
SEI	123 (58.29%)	15 (7.11%)	17 (8.06%)	47 (22.27%)	9 (4.27%)
Total:	1,649 (62.84%)	125 (4.76%)	157 (5.98%)	589 (22.45%)	104 (3.96%)

Table 16 shows the members in each cluster classified by affiliation. It found that the 1st cluster had the most members with 1,649 samples (62.84%). The second group with the largest number of members is the 4th cluster with 589 samples (22.45%), The third group is the 3rd cluster with 157 samples (5.98%), The fourth group is the 2nd cluster with 125 samples (4.76%), and the last group is the 5th cluster with 104 samples (3.96%).

4.2.3. Stress Risk Clustering Model

The stress risk clustering model was reported in three phases: report the optimal k value, report the cluster's centroid, and report the member of each cluster. All details are presented and reported in Fig. 3 and Tables 17-19.

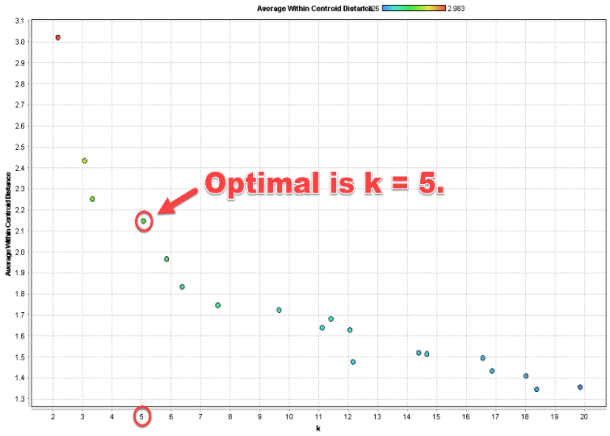

Fig. 3 Optimal k-value for stress risk clustering model

Fig. 3 shows the analysis for selecting the appropriate k-value. It can be concluded that the k-value should be used to create a suitable cluster is k equal to 5 as detailed in Table 17, the centroid of each cluster is shown in Table 18, and the members summary is reported in Table 19.

Table 17 k-value and average within centroid distance (ACD)

k	ACD	k	ACD	k	ACD
2	2.983	8	1.786	14	1.507
3	2.467	9	1.748	15	1.484
4	2.258	10	1.676	16	1.470
5	2.120	11	1.629	17	1.462
6	1.961	12	1.573	18	1.394
7	1.858	13	1.524	19	1.426

Note: ACD = Average within Centroid Distance

Table 18 Centroid of each cluster

Attribute	Centroid				
	S1	S2	S3	S4	S5
1 (s)	0.73	2.01	2.15	1.08	0.32

Continuation of Table 18					
6 (s)	0.71	1.79	0.88	0.58	0.17
8 (s)	0.84	2.11	0.79	0.82	0.11
11 (s)	0.73	1.96	0.58	0.64	0.06
12 (s)	0.69	2.17	0.72	2.32	0.16
14 (s)	1.16	2.02	0.66	1.09	0.13
18 (s)	0.92	1.99	0.59	0.77	0.07

Table 18 shows the centroid of each cluster. It shows the distribution of each attribute. In addition, the example and overall distributions of the member data analyzed are presented in Table 19.

Table 19 Member summary report

Affiliation	**Member**				
	S1	**S2**	**S3**	**S4**	**S5**
AGRO	63 (20.13%)	36 (11.50%)	32 (10.22%)	33 (10.54%)	149 (47.60%)
AGRI	22 (18.64%)	17 (14.41%)	16 (13.56%)	8 (6.78%)	55 (46.61%)
BUSIT	140 (23.10%)	65 (10.73%)	60 (9.90%)	83 (13.70%)	258 (42.57%)
ENAR	83 (23.71%)	37 (10.57%)	38 (10.86%)	44 (12.57%)	148 (42.29%)
HUSO	91 (22.09%)	37 (8.98%)	44 (10.68%)	40 (9.71%)	200 (48.54%)
LA	35 (24.82%)	10 (7.09%)	14 (9.93%)	18 (12.77%)	64 (45.39%)
SCIENCE	13 (19.70%)	7 (10.61%)	6 (9.09%)	7 (10.61%)	33 (50.00%)
SOCIAL	70 (26.52%)	33 (12.50%)	25 (9.47%)	32 (12.12%)	104 (39.39%)
VET	19 (30.65%)	9 (14.52%)	6 (9.68%)	7 (11.29%)	21 (33.87%)
IAT	15 (18.52%)	7 (8.64%)	9 (11.11%)	8 (9.88%)	42 (51.85%)
SEI	49 (23.22%)	26 (12.32%)	26 (12.32%)	28 (13.27%)	82 (38.86%)
Total:	600 (22.87%)	284 (10.82%)	276 (10.52%)	308 (11.74%)	1,156 (44.05%)

Table 19 shows the members in each cluster classified by affiliation. It found that the 5th cluster had the most members with 1,156 samples (44.05%). The second group with the largest number of members is the 1st cluster with 600 samples (22.87%). The third group is the 4th cluster with 308 samples (11.74%). The fourth group is the 2nd cluster with 284 samples (10.82%), and the last group is the 3rd cluster with 276 samples (10.52%).

5. Discussion

The research discussion is divided into two parts: the data collection discussion and the model development analysis.

5.1. Data Collection Discussion

Table 4 shows the population in the research, and Table 5 shows examples of the researcher's collected data. It was analyzed and classified according to various details: Table 6 presents the data by gender and affiliation; Table 7 presents the data by academic year and affiliation. Moreover, Table 8 and Table 9 present the analysis by the impact of the COVID-19. Table 10 presents an analysis of depression risk.

The researchers found that the data gathered coves the whole Rajamangala University of Technology Tawan-ok from data collection and to analysis. The data collected was 2,624 samples from a total of 7,657 students. It is 34.27% of the data collected. It was concluded that the data collected was in the standard. Table 8 and Table 9 show that the collected data were analyzed to determine the impact of the COVID-19. It found that, as a whole, students were affected by the high level of the COVID-19. The most severe impact on the learners was D1-2 (online learning management process), the second impact – D1-5 (impact on learning), the third impact – D2-3: (activities in campus). It can be seen that the impact affects the learning of future learners.

In addition, Table 10 shows the results of an analysis of depression risk. Table 10 shows the depression risk analysis at Rajamangala University of Technology Tawan-ok. It was found that, as a whole, university students had no problems with depression which status is normal (2,316 samples: 88.26%). It corresponded to the state of anxiety and stress among university students, which were normal. However, when considering the opposite, it was found that about 11 percent of university students had to be monitored. The dimension that most students focus on is the anxiety dimension about the Covid-19 situation. It was reflected in the data were analyzed with a moderate level of anxiety with the highest number of 160 samples (6.10%) and appear more concerned with the extremely severe number of 9 samples (0.34%).

5.2. Model Discussion

The three parts of the developed model shown in Figs. 1-3 and Tables 11-19 can be summarized as follows. The analysis of the students' depression showed that most of the students were at normal levels, as shown in Table 10. In addition, Table 13 shows the clusters of members in the normal section as mentioned above. At the same time, the students' anxiety was at normal levels, which are summarized and analyzed in Tables 10 and 15. Finally, the student's stress status was normal, summarized, and analyzed, as reported in Tables 10 and 19. Therefore, it was concluded that this research successfully analyzed depression, anxiety, and stress among students with data mining techniques.

6. Conclusion

The impact of the COVID-19 pandemic in universities has a profound influence on the quality of education of learners. Thus, the research goals were (1) to examine attitudes to the impact of the COVID-19 pandemic in universities and (2) to study the influencing effects on college students' depression. The research sample consisted of 2,624 students from 9 faculties and two institutions: The Faculty Agro-Industrial Technology (AGRO), the Faculty of

Agriculture and Natural Resource (AGRI), the Faculty of Business Administration and Information Technology (BUSIT), the Faculty of Engineering and Architecture (ENAR), the Faculty of Humanities and Social Sciences (HUSO), the Faculty of Liberal Arts (LA), the Faculty of Science and Technology (SCIENCE), the Faculty of Social Technologies (SOCIAL), the Faculty of Veterinary Medicine (VET), the Institute of Aviation Technology (IAT), and the School of Engineering and Innovation (SEI) at Rajamangala University of Technology Tawan-ok. Basic statistics and data mining techniques are used in the analysis of research. It consists of frequency, mean, percentage, standard deviation, k-Mean, k-Determination. The results of the study revealed that the students had a severe attitude towards the COVID-19 epidemic situation. The impact that students are most concerned about is the online learning management process. In addition, the overall opinion of the respondents had a high level of anxiety about learning management. In addition, the data-mining analysis showed that it was consistent with most normal levels of depression, anxiety, and stress among students.

The scientific novelty was the integration of artificial intelligence technology to manage education in the COVID-19 pandemic proactively. The results revealed that the use of artificial intelligence technology in the proactive management of education is critical. It can define groups that are significant to managing problems, as shown in Fig. 1 to Fig. 3. Each group has categorized the severity of stress, anxiety, and depressive states, which are very helpful in preparing for future problems.

The limitation of the study was that the research sample was still limited to one university. It is imperative to expand the educational target audience to be more inclusive and diverse.

In future research, the researcher plans to develop an application program to support organization management with modern technology and to prepare students for the future of learning.

Acknowledgment

This research project was supported by the Thailand Science Research and Innovation Fund and the University of Phayao (Grant No. FF64-UoE004). In addition, this research was supported by many academics, researchers, students, staff, and agencies from two organizations: Rajamangala University of Technology Tawan-ok, and the School of Information and Communication Technology at the University of Phayao. The authors would like to thank all of them.

References

[1] NUANKAEW P., NUANKAEW W., NASA-NGIUM P., PHANNIPHONG K., TEERAPUTON D., and CHAOPANICH O. Attitude towards Online Learning from the Effect of Coronavirus 2019 Disease (COVID-19) of University Students in Thailand. *Palestinian archaeology's Journal of Archaeology of Egypt/Egyptology*, 2021, 18(4): Art. 4.

[2] CAHAPAY M. B. Rethinking Education in the New Normal Post-COVID-19 Era: A Curriculum Studies Perspective, *Aquademia*, 2020, 4(2): 20018. DOI: 10.29333/aquademia/8315.

[3] ABUHAMMAD S. Barriers to distance learning during the COVID-19 outbreak: A qualitative review from parents' perspective. *Heliyon*, 2020, 6(11): e05482. DOI: 10.1016/j.heliyon.2020.e05482.

[4] AKHTER T. Problems and Challenges Faced by EFL Students of Saudi Arabia during COVID-19 Pandemic. *Rupkatha Journal on Interdisciplinary Studies in Humanities*, 2020, 12(5): 1–7. DOI: 10.21659/rupkatha.v12n5.rioc1s23n5.

[5] AUCEJO E. M., FRENCH J., ARAYA M. P. U., and ZAFAR B. The Impact of COVID-19 on Student Experiences and Expectations: Evidence from a Survey. *Journal of Public Economics*, 2020,191: 104271.

[6] ABDEL-BASSET M., CHANG V., and NABEEH N. A. An Intelligent Framework using Disruptive Technologies for COVID-19 Analysis. *Technological Forecasting and Social Change*, 2021, 163: 120431. DOI: 10.1016/j.techfore.2020.120431.

[7] ALMARZOOQ Z. I., LOPES M., and KOCHAR A. Virtual Learning During the COVID-19 Pandemic: A Disruptive Technology in Graduate Medical Education. *Journal of the American College of Cardiology*, 2020, 75(20): 2635-2638. DOI: 10.1016/j.jacc.2020.04.015.

[8] SINTEMA E. J. Effect of COVID-19 on the Performance of Grade 12 Students: Implications for STEM Education. *Eurasia Journal of Mathematics Science and Technology Education*, 2020, 16(7): 1851. DOI: 10.29333/ejmste/7893.

[9] CHAPMAN P., CLINTON J., KERBER R., KHABAZA T., REINARTZ T., SHEARER C., and WIRTH R. CRISP-DM 1.0: Step-by-step data mining guide. *Statistical Package for the Social Sciences Incorporated*, 2000, 9: 13.

[10] WIRTH R. and HIPP J. CRISP-DM: Towards a Standard Process Model for Data Mining. In *Proceedings of the Fourth International Conference on the Practical Application of Knowledge Discovery and Data Mining*, 2000: 29-39.

[11] OEI T. P., SAWANG S., GOH Y. W., and MUKHTAR F. Using the depression anxiety stress scale 21 (DASS-21) across cultures. *Int. J. Psychol.*, 2013, 48(6): 1018-1029.

[12] NUANKAEW P. and TEMDEE P. Matching of Compatible Different Attributes for Compatibility of Members and Groups. *International Journal of Mobile Learning and Organisation*, 2019, 13(1): 4-29. DOI: 10.1504/IJMLO.2019.096469.

[13] NUANKAEW W. and NUANKAEW P. Tolerance of Characteristics and Attributes in Developing Student's Academic Achievements. *Advances in Science, Technology and Engineering Systems Journal*, 2020, 5(5): 1126-1136, DOI: 10.25046/aj0505137.

[14] NUANKAEW W. and NUANKAEW P. Educational Engineering for Models of Academic Success in Thai Universities During the COVID-19 Pandemic: Learning

Strategies for Lifelong Learning. *International Journal of Engineering Pedagogy*, 2021, 11(4): Art. 4. DOI: 10.3991/ijep.v11i4.20691

参考文:

[1] NUANKAEW P.、NUANKAEW W.、NASA-NGIUM P. 、 PHANNIPHONG K. 、 TEERAPUTON D. 和 CHAOPANICH O. 泰國大學生從 2019 年冠狀病毒病 (新冠肺炎) 影響在線學習的態度.巴勒斯坦考古學的埃及考古學雜誌/埃及學，2021 年，18(4)：藝術。 4.

[2] CAHAPAY M. B. 重新思考 新冠肺炎後新常態時代的教育：課程研究視角，水族館， 2020, 4(2): 20018. DOI: 10.29333/aquademia/8315。

[3] ABUHAMMAD S. 新冠肺炎爆發期間遠程學習的障礙：從父母的角度進行的定性審查。赫利永, 2020, 6(11): e05482。 DOI：10.1016/j.heliyon.2020.e05482。

[4] AKHTER T. 新冠肺炎大流行期間沙特阿拉伯英语學生面臨的問題和挑戰。魯普卡塔人文學科跨學科研究雜誌，2020 年，12(5) ：1-7 。 DOI ：10.21659/rupkatha.v12n5.rioc1s23n5。

[5] AUCEJO E. M.、FRENCH J.、ARAYA M. P. U. 和 ZAFAR B. 新冠肺炎對學生體驗和期望的影響：調查證據。公共經濟學雜誌，2020，191：104271。

[6] ABDEL-BASSET M.、CHANG V. 和 NABEEH N. A. 使用破壞性技術進行 新冠肺炎分析的智能框架。技術預測與社會變革，2021 年，163 ：120431 。 DOI ：10.1016/j.techfore.2020.120431。

[7] ALMARZOOQ Z. I.、LOPES M. 和 KOCHAR A. 新冠肺炎大流行期間的虛擬學習：研究生醫學教育中的顛覆性技術。美國心髒病學會雜誌，2020，75（20）：2635-2638。 DOI：10.1016/j.jacc.2020.04.015。

[8] SINTEMA E. J. 新冠肺炎對 12 年級學生表現的影響：對干教育的影響。歐亞數學科技教育雜誌, 2020, 16(7): 1851. DOI: 10.29333/ejmste/7893.

[9] CHAPMAN P.、CLINTON J.、KERBER R.、KHABAZA T.、REINARTZ T.、SHEARER C.、和 WIRTH R. 酥脆-DM 1.0：分步數據挖掘指南。社會科學公司統計資料包，2000 年，9：13。

[10] WIRTH R. 和 HIPP J. 酥脆-DM：邁向數據挖掘的標準過程模型。在第四屆知識發現和數據挖掘的實際應用國際會議論文集，2000 年：29-39。

[11] OEI T. P.、SAWANG S.、GOH Y. W. 和 MUKHTAR F. 跨文化使用抑鬱焦慮壓力量表二十一。國際。 J. 心理学。, 2013, 48(6): 1018-1029。

[12] NUANKAEW P. 和 TEMDEE P. 匹配不同屬性以實現成員和組的兼容性。國際移動學習與組織雜誌，2019, 13(1)：4-29。 DOI：10.1504/IJMLO.2019.096469。

[13] NUANKAEW W. 和 NUANKAEW P. 發展學生學業成績的性格和屬性的容忍度。科學、技術與工程系統進展期刊, 2020, 5(5): 1126-1136, DOI: 10.25046/aj0505137。

[14] NUANKAEW W. 和 NUANKAEW P. 新冠肺炎大流行期間泰國大學學術成功模式的教育工程：終身學習的學習策略。國際工程教育學雜誌, 2021, 11(4): 藝術。 4. DOI：10.3991/ijep.v11i4.20691