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Analyzing the Factors that Hinder the Implementation of ICT in Teaching-Learning Process in Rural Area by using Analytic Hierarchy Process

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ABSTRACT

The rapid growth of digital technology today is having profound effects on labor markets and economies. Education is no exception. To support teaching and learning education, technology infuses the classroom with digital learning tools or materials. In Malaysia, the Ministry of Education has initiated, supported, and encouraged the introduction of Information Communication and Technology (ICT) into education policy, believing that the education level can have better quality by integrating ICT into the teaching and learning process. However, the level of using ICT for teaching in rural area remains low compared to an urban area due to some factors. This study aims to analyze and rank ten significant factors (lack of sufficient training, lack of time, lack of confidence, lack of ICT resources and facilities, lack of ICT integration skill, attitude and perception toward ICT use, lack of accessibility and network connection, lack of support assistance, teaching experiences and age, and workload) according to the level of importance that hinder the implementation of ICT in secondary schools by using Analytics Hierarchy Process (AHP) method. The targeted samples are school teachers in a rural area in Kedah, Malaysia. The result shows that lack of ICT integration skill, workload, and lack of support are the top three factors that impede the integration of ICT in the rural area. Conversely, the factor of lacking time does not bring obvious impact on this issue.

Keywords: AHP, ICT education, rural, secondary schools, teaching-learning process.

1 INTRODUCTION

Nowadays, Information Communication and Technology (ICT) have become crucial as it impacts every aspect of our daily lives. ICT in education can be defined as a diverse set of technological tools and resources that use to create, communicate, disseminate, manage, and store information [1]. People are fully relying on technology to search or retrieve useful global information. The common ICT tools are computers, smartphones, video conferences, digital television, email, news and etc. [2], [3]. ICT is also beneficial to education. ICT implementation in the education sector has been introduced by the Ministry of Education (MoE) Malaysia since 1970 and initiates the computer education programme in 1999's.

MoE has stressed the implementation of ICT in the teaching process in Malaysia's education plan since 2005. Three core policies of ICT have been developed in education which are opportunities of accessing ICT to all students, the role and function of ICT in education, and emphasizing the use of ICT to improve the effectiveness, efficiency, and productivity tools of education management [4], [5]. Integrating ICT in teaching-learning would improve students' learning ability, critical thinking, and problem-solving skills. The technology advancements enable new ways to execute work, bring new opportunities, improve communication, and prepare skilled workers to embrace the rise of the new digital industrial revolution (IR4.0). Therefore, the MoE has spent more than RM 6 billion to support Information and Communication Technology (ICT) by scaling up learning quality in 10,000 secondary schools in Malaysia [6].

ICT tools have been introduced and widely used in Malaysia's educational process since 1970 [7]. Logically, in 21st century, it should be well implemented in current teaching and learning approaches. However, not every secondary school fully implements ICT tools in their teaching and learning process in Malaysia. Majority of the secondary school teachers are aware of the benefits that technology could bring to the learners, and they desire to get quick attention from the government, but in reality, most of secondary schools in Malaysia have not yet achieved the consistency of using ICT in teaching especially in rural areas [8]. [9] found that schools in rural areas are lacking experience in the use of blended learning. [10] stated that most rural students agree with the facilities availability factor significantly impact ICT use in rural schools' library and pedagogical process. Limited facilities and resources would impede the application of ICT technology in knowledge delivery [11]. Besides that, the large skills or knowledge gap between rural and urban teachers have also been widened by environmental factors, particularly in terms of equipment availability. According to [12], teachers in Malaysia had a low level of ICT integration in school. Teachers are using ICT technology as a medium for searching teaching materials before conducting classes but not to engage them in various teaching activities. Yet, [13] has conducted research in Kedah's secondary school about the technology used in the teaching-learning process, the finding shows that the principal technology leadership abilities of technology are at a high level and the teacher's computer use is only in the moderate level. However, there is no relationship between teacher's computer use and principal technology leadership. It means that the principal as a leader of the schools should stress on ICT integration in the teaching-learning process. Furthermore, some teachers are discouraged by integrating ICT in their teaching as they are lacking accessibility, resources and facility, adequate training, time, and confidence [14]. Integrating ICT into teaching is a complex process that may encounter many difficulties and challenges. From teachers' perspectives, the influential factors are uncovered and stated as shown below.

i. Lack of sufficient training

According to [1], new technologies need to be integrated into classrooms and the teachers need to be trained in the use of ICT tools. In this regard, teachers are required to have some initial training to develop appropriate skills, knowledge, and attitudes to effectively use computers to support learning. [15] stated that non-continuous training affects the use of ICT for teaching and that over time, the skills learn, and their memory of content diminishes. Typically, training takes about three to four days, which is certainly not enough to cover all modules of learning new software. Short training time may also affect the educator to build their self-confidence in managing the computer skills in class. In the long run, non-continuous training is not an effective training policy because teachers are not well trained in mastering the computer skills.

ii. Lack of time

[15], and [16] stated that lack of time is the most common challenging factor in integrating ICT in the pedagogy process. Teachers have to plan technical courses, browse different websites, or educational software to prepare the teaching materials and teach in the class. Similar to [17], teachers do not have time to plan and integrate ICT into their lessons because they are rushing to achieve the syllabus's goals. Preparation for courses using ICT is time-consuming because an hour of ICT intensive courses takes approximately 3-4 hours of preparation time. As a result, teachers face problems in preparing their courses or teaching due to time limitation. [18] showed that teachers believe that they do not have enough opportunities to practice using computers in their teaching process. Teachers regularly schedule the lesson fit with the limited period, and that the lack of time requires integrating ICT into the curriculum successfully is a recurring challenge.

iii. Lack of confidence

[17] focused on English language subjects, and they found that teachers prefer traditional teaching methods in classroom because they lack motivation, reluctant to accept the ICT integration and adoption in the teaching process. [16] illustrated that many teachers are not computer-literate; they are struggling to master the computer skills. [19] pointed out that lack of confidence is closely related to lack of motivation, lack of knowledge, and lack of awareness of ICT benefits. [1] revealed that some teachers are anxious and fear for making mistakes.

iv. Lack of ICT resources and poor infrastructure

[16] reported that despite ongoing efforts to integrate ICT in schools, many families especially in rural areas, still do not master in dealing with ICT tools in their daily lives. The result showed that the main challenge is the adequate provision of appropriate ICT tools to urban and rural areas because the technologies and facilities in urban and rural areas are different. [20] indicated that integrating ICT into education requires significant budgetary and financial investment. Investments should include not only the purchase of new equipment and software but also the development of school infrastructure, for example, by installing Wi-Fi, adjusting classroom settings where necessary and, refurbishing and maintaining existing equipment. [1] found that most institutions have computers. However, the number of devices is minimal and, in most cases, is being used by students from courses of computer science and information technology (IT), putting the rest of the students and teachers in an awkward position.

v. Lack of ICT integration skill

[1] figured out that unreliable and pirated software that is frequently changed (not a permanent software, will keep on changing or updating to another new software) in computer labs and is difficult to use appropriately in teaching. Limitations on access to hardware and software resources affect teachers' motivations for using ICT in the classroom. [19] discovered that the lack of support is associates with inadequate ICT integration, underfunding, faulty hardware and software maintenance, and power outages. [21] found that teachers do not know how to use ICT in teaching, they do not have the ICT skills they need, do not have the time to learn ICT skills. Furthermore, some teachers are cumbersome in managing the digital teaching devices.

vi. Attitude towards ICT

[1] claimed that one of the problems with implement ICT in teaching is the reluctance of using new technologies. The attitude of teachers is an essential predictor of the use of new technologies in the teaching environment. The successful use of new technologies in the classroom depends fundamentally on teachers' attitude towards these tools. However, if teachers are exposing to ICT at an early stage of their careers, they may be interested in promoting the potential of attractive teaching and learning courses [15]. [21] found that teachers' negative attitudes towards ICT use are not interesting in applying ICT in teaching; they do not discover how di teaching helps students better understand science. They believe that ICT does not benefit in their teaching and therefore they perceive that the implementation of science courses is not necessary. Besides, the factors of lack of accessibility and network connection [16], lack of support assistance [15], workload, and teaching experience and ages [17] are also the constraints that hinder the implementation of ICT in teaching.

1.1 Multi-Criteria Decision Making (MCDM)

To investigate the domain of this issue in Kedah state, we undergo a study by determining the potential factors according to the level of importance by using multi-criteria decision making (MCDM) approach. According to previous researchers, [15], [16], [17], and [21] had identified several factors that hinder the implementation of ICT teaching. However, the factors were not ranked based on the importance level prior to carrying out the inference statistics analysis. Ranking according to the significant level, would be effectively fix the issues and allow the researchers to present the proper solutions to solve the problem. Generally, MCDM provides time flexibility, the importance of accuracy, transparency, and conflicts minimization [22]. MCDM can help in reducing the risk in the product design process and increase the likelihood of delivering required product specifications to a fixed program. The use of well-structured material selection is one way to limit or reduce unnecessary costs. The common techniques of MCDM are analytical network process (ANP), analytical hierarchy process (AHP), Simple Additive Weighting (SAW), data envelopment analysis (DEA), Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) and many else [23].

Among all, Analytic Hierarchy Process (AHP) is used in our study due to the simplicity and its precision. AHP allows consistency and cross checking between the different pairwise comparisons. The hierarchical analysis can be divided into three main stages, namely, hierarchy structure, priority analysis, and consistency validation [24]. AHP allows a hierarchical structure of criteria, to pay better attention to specific criteria and sub-criteria when assigning weights [25]. It also takes the relative priority of factors into consideration. The use of technology in education has made a significant contribution to teaching, and the application of ICT will lead to active learning in almost all subjects with the help and support of ICT elements and components. However, not all secondary schools in Malaysia implement and use ICT as supplementary material or tool in the teaching process, especially in rural areas. Teachers who teach in rural areas are aware of the benefits of ICT integration in pedagogical brings to education and students, there are still some hindering factors that impede the ICT integration in rural areas. Therefore, the factors that obstruct the ICT implementation in the teaching-learning process in Kedah's rural secondary schools are ranked according to their level of importance.

2 MATERIAL AND METHODS

This study aims to develop an AHP model to rank the influence factors that hinder the implementation of ICT in teaching and learning. The selected respondents are teachers who are teaching in rural area.

2.1 Data Collection and Sampling

There are 19 rural schools with 811 teachers who teach in Kedah's rural secondary schools. Stratified random sampling is used to select the sample in this study. Stratified random sampling is also known as a probability sampling method that completes the sampling process by dividing the total population into smaller groups or classes. After dividing the population into classes, we randomly select the samples proportionally. Then, a questionnaire is developed and distributed to 23 targeted teachers.

2.2 Data Analysis

The data is analyzed using the AHP method to rank the critical factors according to the level of importance. Ten influential factors that affect the ICT integration in the secondary schools in Kedah have been identified. According to [26], AHP method does not require large sample size as it depends on the occurrence of the events. Moreover, the experts' opinions will be varied that would cause instability to the results. Table 1 shows the AHP construction model [27].

Table 1 : Steps to construct AHP method

Steps	Explanation
Step 1:	Identify the issue as well as the data types required.
Step 2:	Create a decision hierarchy based on the objectives. Table 2 below shows the comparative measurements using between two criteria using the scale of 1-9.
Step 3:	Construct a set of pairwise comparison matrices. Each factor at the higher level is compared to the factors associated with the level below.
Step 4:	Rank the criteria by using AHP. Computed the Geometric Mean after constructing a pairwise comparison matrix. After that, compute the total row and total column to define the weight of each factor.
Step 5:	Conduct the consistency test. Compute the Consistency Index (CI), and Consistency Ratio (CR) to test for the acceptance of the consistency.
Step 6:	Rank and interpret the result.

Table 2 : Pairwise comparison of criteria with respect to the overall goal

Comparative importance	Description
1	Equally importance
3	Weak importance of one over another
5	Essential importance
7	Demonstrated importance
9	Absolute importance
2, 4, 6, 8	Intermediate values between comparative (1, 3, 5, 7, 9) slightly favor to one activity

The pairwise comparison is carried out in AHP, and it is based on nine-levels standardized measurement scales. The relative-scale pairwise comparisons is used to compare each element and determine the values based on the experience and knowledge. The scale used for comparison in AHP enables us to visually absorb experience and knowledge intuitively [28]. Besides, Figure 1 shows the factors and decision options that influence selecting teaching and learning tools.

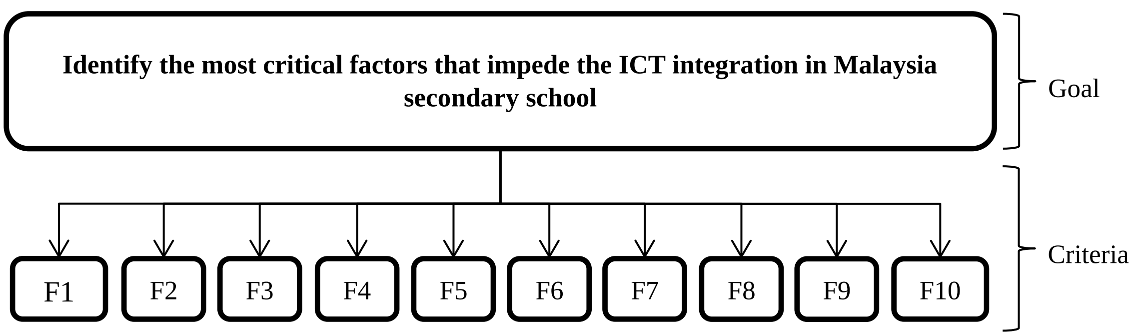

Figure 1 : AHP diagram

Due to the impact of measurement criteria relative to the goal, the pairwise comparison is important in the design analysis hierarchy process. The pairwise comparison shows a fair comparison between the criteria and the main objectives of this study.

The criteria stated above in Figure 1 are *lack of sufficient training* (F1), *lack of time* (F2), *lack of confidence* (F3), *lack of ICT resources and facilities* (F4), *lack of ICT integration skill* (F5), *attitude and perception toward ICT use* (F6), *lack of accessibility and network connection* (F7), *lack of support assistance* (F8), *teaching experiences and age* (F9), and *workload* (F10).

3 RESULTS AND DISCUSSION

Table 3 shows a set of the pairwise comparison matrix for each factor. To ensure that the judgment is consistent, the consistency validation must be performed. Consistency is determined by the Consistency Ratio (CR) where the CR is the ratio of the consistency index (CI) to the random index (RI) of the same order matrix.

Table 3 : Pairwise comparison of criteria with respect to the overall goal

Criteria	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10
F1	1	2.3871	1.8846	0.9272	0.7308	0.6102	1.2351	0.7524	0.8351	0.7204
F2	0.4189	1	1.3820	0.7041	0.7969	0.7852	0.8215	0.7638	0.7948	0.8706
F3	0.5306	0.7236	1	0.7518	0.6098	1.9331	1.4189	0.8394	0.3438	0.8276
F4	1.0785	1.4203	1.3301	1	1.1721	0.4565	0.7890	0.9758	1.1097	0.7185
F5	1.3684	1.2549	1.6398	0.8531	1	0.9445	0.7147	0.9412	2.7704	1.7522
F6	1.6389	1.2735	0.5173	2.1904	1.0588	1	0.6088	0.6223	0.5182	0.7630
F7	0.8096	1.2173	0.7048	1.2674	1.3992	1.6425	1	0.8146	1.1142	0.8312
F8	1.3291	1.3092	1.1913	1.0248	1.0625	1.6069	1.2277	1	1.0959	0.6571
F9	1.1975	1.2581	2.9085	0.9011	0.3610	1.9299	0.8975	0.9125	1	0.6326
F10	1.3882	1.1487	1.2084	1.3918	0.5707	1.3106	1.2030	1.5219	1.5807	1
Column Total	**10.7597**	**12.9926**	**13.7668**	**11.0118**	**8.7619**	**12.2195**	**9.9162**	**9.1439**	**11.1629**	**8.7732**

Table 4 shows the values of weight (PV) and average weight (Ax) (sum of the values from the outcome of each row value divided by each total row value) for each criteria.

Table 4: Weight (PV) and average weight (Ax) for each criteria

Criteria	Weight (PV)	Average weight (Ax)
F5	0.1235	1.3281
F10	0.1147	1.2179
F8	0.1063	1.1342
F9	0.1052	1.1373
F7	0.1014	1.0817

F1	0.0995	1.0518
F6	0.0952	1.0054
F4	0.0936	0.9926
F3	0.0834	0.8860
F2	0.0772	0.8212

The maximum eigenvalue (λ_{max}) formula is the average value of summing each Ax's value divided by each PV's value.

$$\lambda_{max} = \left(\frac{Ax_1}{PV_1}\right) + \left(\frac{Ax_2}{PV_2}\right) + \cdots + \left(\frac{Ax_n}{PV_n}\right) \tag{1}$$

$$\lambda_{max} = \frac{[\left(\frac{1.3281}{0.1235}\right) + \left(\frac{1.2179}{0.1147}\right) + \left(\frac{1.1342}{0.1063}\right) + \left(\frac{1.1373}{0.1052}\right) + \left(\frac{1.0817}{0.1014}\right) + \left(\frac{1.0518}{0.0995}\right) + \left(\frac{1.0054}{0.0952}\right) + \left(\frac{0.9926}{0.0936}\right) + \left(\frac{0.8860}{0.0834}\right) + \left(\frac{0.8212}{0.0772}\right)]}{10}$$

$$= 10.6516$$

The λ_{max} is needed to find theCI. The CI is calculated using the formula

$$CI = \frac{\lambda_{max} - n}{n - 1} \tag{2}$$

$$CI = \frac{10.6516 - 10}{10 - 1}$$

$$= 0.0724$$

CR is calculated to determine the reliability of the pairwise comparison. CR is the ratio of CI to RI for the same order matrices. The RI estimators in Table 5 are obtained from [29].

Table 5: Ratio Consistency Index

Matrix Size (n)	1	2	3	4	5	6	7	8	9	10
RI	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49

The RI value should match with the matrix size based on Table 5. Since the n in this study is 10, therefore, the RI of 1.49 is selected.

$$CR = \frac{CI}{RI} \tag{3}$$

$$= \frac{0.0724}{1.49}$$

$$= 0.0486$$

The CR is 4.86%, which is less than 10%. Therefore, the matrix is considered as consistent.

Table 6 shows the *lack of ICT integration skill* factors hold the highest value (0.1235 or 12.35%) among the other factors. The second highest is the *workload* with a value of 0.1147 (11.47%), and the third highest is the *lack of support assistance* with a value of 0.1063 (10.63%), followed by *teaching experiences and age* (10.52%), *lack of accessibility and network connection* (10.13%), *lack of sufficient training* (9.95%), *attitude and perception toward ICT use* (9.52%), *lack of ICT resources and facilities* (9.36%), *lack of confidence* (8.34%). The least influence factor is *lacking time* with the value of 0.0772 (7.72%).

Table 6 : Factors ranked from the rural schools' outputs

Criteria	Weight	Ranking
F5	0.1235	1
F10	0.1147	2
F8	0.1063	3
F9	0.1052	4
F7	0.1014	5
F1	0.0995	6
F6	0.0952	7
F4	0.0936	8
F3	0.0834	9
F2	0.0772	10

4 CONCLUSION

AHP is used to rank the factors that affected the ICT implementation in Kedah rural area secondary schools. Three main factors that hinder the implementation of ICT in Kedah rural secondary schools are the factors of *lack of ICT integration skills*, *workload*, and *lack of support assistance*. Therefore, the different numbers of ICT integration training in rural school areas should be increased, and the government should also update the ICT equipment in rural areas to resolve the issues. Conversely, the factors of *lack of confidence* and *time* seem do not bring an obvious impact to this issue. The results of this study would certainly provide useful information to the Minister of Education for developing the new strategic planning and policy for implementing ICT in education. In conjunction to this, Malaysia's education will surely accomplish higher level of technology advancement towards Industrial Revolution (IR) 4.0. For future work, this study can be extended by covering urban areas in order to compare if there is a significant difference between schools in rural and urban areas.

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