

An ICT Adoption Framework for Education: A Case Study in Public Secondary School of Indonesia

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Abstract. This paper presents preliminary research findings on the ICT adoption framework for education. Despite many studies have been conducted on ICT adoption framework in education at various countries, they are lack of analysis on the degree of component contribution to the success to the framework. In this paper a set of components that link to ICT adoption in education is observed based on literatures and explorative analysis. The components are Infrastructure, Application, User Skills, Utilization, Finance, and Policy. The components are used as a basis to develop a questionnaire to capture the current ICT adoption condition in schools. The data from questionnaire are processed using Structured Equation Model (SEM). The results show that each component contributes differently to the ICT adoption framework. Finance provides the strongest affect to Infrastructure readiness, whilst User Skills provides the strongest affect to Utilization. The study concludes that development of ICT adoption framework should consider components contribution weights among the components that can be used to guide the implementation of ICT adoption in education.

1. Background

During the past decade a vast number of reports have been published on global initiatives to improve education quality. Among those initiatives there is an increased government investment to support adopting information and communication technology (ICT) in teaching, learning, and administration at public schools through ICT integration into existing pedagogies. It is expected to transform teaching and learning. Improving education quality in various countries has common long-term objectives including strengthening global competitive, economic growth, social conditions, and human development index. Several statistical analysis have shown that enhancing Education Index (EI) affect significantly ICT Development Index (IDI) which in turns increased Human Development Index (HDI).

ICT usage in daily life activity has become a common practice by almost people in the world. Using technology is conducted to make the work completion more efficient and the result is better. ICT is all technology used to handle (e.g. save, update, manipulate, organize, distribute, forward, etc.) information and communication, such as internet, computer, email, smartphone, including software supported. Internet is the famous growth parameter of ICT. By the end of 2016, seven billion people (95% of the global population) live in an area that is covered by a mobile-cellular network, and 3.9 billion people (53% of the global population) is not using the internet, it means that close to one out of two people (47%) in the world are using the internet, but only one out of seven people in the LDCs [1].



Global ICT development index from ITU released in early 2016 (see Figure 1) show the growth of phone and internet user in last 15 years. Active mobile-broadband user subscription started in 2007 and increase faster than most others. It also shows that a decrease in fixed telephone subscribers (fixed telephone subscription). It happened probably due to the flexibility and ease of buying and installing mobile phone connections than fixed telephone lines.

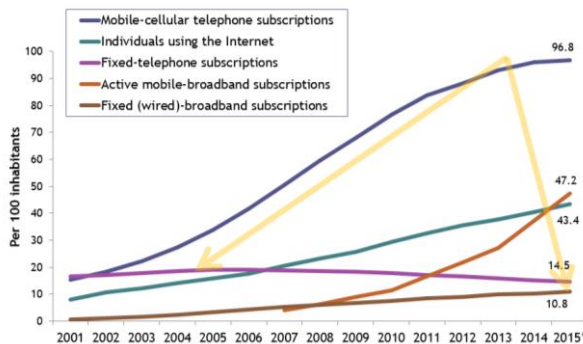


Figure 1. ICT development variable (2001 – 2015)
 Source: ICT fact and figures (ITU, 2016)

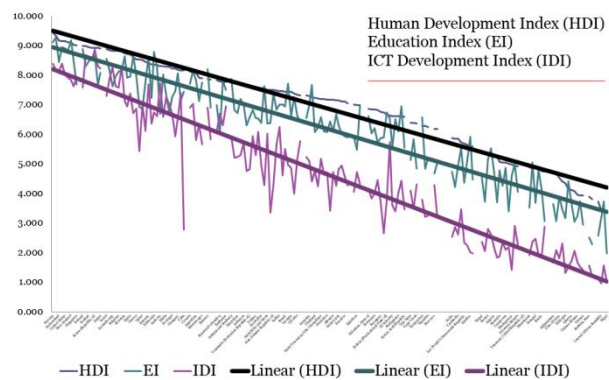


Figure 2. Global ICT development index and human development index (HDI) (2001 – 2015)
 Source: Compiled from ITU (2015), UNDP (2015)

ICT usage is adopted in many sectors for specific purpose in many life sectors (health, education, politic, etc.). So, ICT adoption means the use of ICT for particular purpose. ICT adoption influences user in achieving the goal of any purpose. It means ICT adoption in education might impact to the goal of education. At the other view, increasing ICT Development Index (IDI) indicates that Education Index (EI) also increase, where EI is a part of Human Development Index (HDI) as shown as Figure 2.

ICT adoption in education is a common term refers to the use of ICT in teaching, learning, and administration aimed to strengthen the achievement of education goals, priorities, and strategies. There is encouraging evidence that ICT can be an effective tool in supporting teaching and learning. There is a common believe among education policy makers in various countries that the necessary condition for effectively introducing technology into schools are mainly the availability and accessibility of ICT resources. The resources are including: computer hardware, software, communications infrastructure, digital content, technical as well as Finance support for ICT operation and maintenance.

Some researchers found that one of the greatest challenges in ICT use in education is balancing educational goals with economic condition. ICTs in education programs require large capital investments. Some special attention should be paid to areas in developing countries due to the digital divide. To achieve a greater development of ICT-supported education systems will require new approaches to teaching and learning, and new types of technologies to support those new approaches in schools [2]. That is why designing an ICT policy in education is a far more complex task than merely deploying hardware in the schools.

From the best of our knowledge, little has been said clearly about what/how component contribute to the success of ICT adoption framework. Therefore, the objective of this research is two folds: (1) investigating components that affect ICT adoption in education, and (2) proposing a conceptual framework for adopting ICT in education, especially in public secondary schools in Indonesia. Moreover, the contribution is mainly to provide information to education policy maker regarding the issue what components contribute to the success of ICT adoption in secondary schools in Indonesia.

This information is valuable in helping policy maker to ensure that decision making in education will effectively enhance education quality for students.

The rest of the paper is organized as follows. Section 2 describes some related works. Section 3 explains the research methodology. Section 4 explains the results and discussion of the study followed by conclusion and future works in Section 5.

2. Related works

Review of related works cover theories, cases and practices about components of ICT adoption for Education

2.1. Theories related to ICT adoption in education

Regarding to the research question, this research must find the answer about: (1) What components that affect ICT adoption in education including how these components interact within a framework; and like what and how a conceptual framework for adopting ICT in education, especially in public secondary schools in Indonesia. There are six components of ICT adoption in education gathered from literature which mapped as shown in Table 1.

Table 1. Component's map

Source \ Components	Infrastructure	Application	User Skills	Utilization	Policy	Finance
Doshi, 2014. [3]	✓	✓	✓	✓		
HU, 2012. [4]	✓	✓		✓		
Langrova and Poulova, 2013. [5]	✓	✓	✓			
Wang and Zhou, 2013. [2]	✓	✓	✓	✓		✓
Hepp, 2003. [6]	✓	✓	✓	✓	✓	
Poulova and Simonova, 2014. [7]	✓	✓	✓	✓		
Tabira and Otieno, 2014. [8]	✓		✓	✓		
Zain and Murugaiah, 2004. [9]	✓	✓	✓	✓	✓	✓
Goyal and Purohit, 2011. [10]	✓	✓	✓	✓	✓	✓
Sooryanarayan DG and Rekha, 2014. [11]	✓	✓	✓	✓	✓	✓
Ila and Kitapci, 2014. [12]	✓	✓		✓	✓	
Arshad and Noman Saeed, 2014. [13]	✓	✓	✓	✓	✓	✓
Jemni, 2014. [14]		✓			✓	
Bo and Ming-Sheng, 2010. [15]	✓			✓	✓	✓
Haruzuan, Eamas and Forret, 2013. [16]		✓		✓		
Šumak, G. Polančič and Heričko, 2010. [17]		✓		✓		
Tatnall, 2008. [18]	✓	✓		✓		
Zahariev, Ruseva, Hristov and Benchev, 2013. [19]	✓	✓	✓	✓		✓
Panangalage and Pasqual, 2008. [20]	✓		✓	✓	✓	
Rekha and Adimarayanan, 2014. [21]		✓	✓	✓		✓
Sharma, GOH, SUN and HO, 2014. [22]	✓	✓				

There are almost all literatures about ICT adoption in education examine those six components. In each components, there are still factors inside which contribute entirely.

2.2. Cases and practices from various countries

Many studies on ICT adoption in education in various countries have been reported and the summary as Table 2.22. The result of brief review on ICT adoption involving some prominent works from countries is summarized as Table 2.

Table 2. ICT adoption indicators in countries

No	Countries Factors Mapped into Components	United States	Canada	England	France	Germany	Italy	Japan	Russia	Malaysia	Singapore	Indonesia
I	INFRASTRUCTURE											
1	Computer per schools rate			X			X	X				
2	Computer laboratory per schools rate									X		X
3	Student per computer ratio	X	X	X	X		X	X		X	X	X
4	Schools internet connection							X				
5	Computer connects to internet					X	X					
6	Internet access					X	X	X				
II	APPLICATION											
1	Schools has email											X
2	Schools has website							X				
3	Schools has specific application	X										
III	USER SKILLS											
1	Teacher has ICT skill in teaching student							X				
2	Administration Staff has ICT skill in managing school										X	X
3	Student has basic ICT skill in learning				X	X	X					
IV	UTILIZATION											
1	Student use ICT during studying	X	X	X	X		X	X				X
2	Teacher utilize ICT during teaching	X						X				
V	POLICY											
1	Schools follow Government's program in implementing ICT	X	X	X	X	X	X	X		X	X	X
VI	FINANCE											
2	Schools receive Government's Finance support in implementing ICT	X	X	X	X	X	X	X	X	X	X	X

Source: compiled from cross-national ICT report [23].

2.3. Cases in Indonesia

For additional information, there are few cases ICT adoption in education related to the components specifically in Indonesia:

1. Ministry of Education Indonesia database tells there are 212,671 national schools in Indonesia and shows 157,656 schools have computers, but still 87,213 schools only have 1 or 2 computers. 190,604 schools have email. 180,990 mobile schools have a contact number and 11,370 schools have websites [24].
2. Ministry of Education Indonesia periodically granted to some schools with general specification of ICT supply, such as computers, networks and LCD screens. Schools receive the grant and start using ICT with general guide. There are not yet any comprehensive guidance which can drive schools to adopting ICT in appropriate way.

3. Ministry of Education Indonesia provide Jardiknas as internet backbone to supply internet connection to schools and education centre. Jardiknas also provide network domain name email and clouds service to ministry office [25].
4. Ministry of Education Indonesia provide centralized education database (Dapodik) which support detail historical education information. Almost all ministry's policy use data from Dapodik.
5. To strengthen the learning process, in 2008, the Ministry of Education bought the copyright from the authors of textbooks and waive the use of the book in digital form. The digital textbook, Electronic School Book (BSE). In 2010, the Ministry of Education released a Content Management System (CMS) for a school that is Free Open Source.

3. Research design

The research design is combined explorative and confirmative based on premise that there exists an association between observed variables that construct the investigated latent variables and causal relationship among these latent variables in related to ICT adoption in education [26]. In general, the target population of this research comprises: principals of public secondary school in Indonesia, ICT content developers and education specialist, and policy makers in Ministry of Education Republic of Indonesia.

Sampling technique in this research adopted both purposive and systematic random sampling techniques. Purposive sampling ensured that prominent digital/non-digital educational content developers, and policy makers can be selected in order to collect much information concerning the subject of study. Systematic random sampling, in this preliminary study, was used to select respondents from school principals.

3.1. Research phase and data collection

The research activities can be divided broadly into three phases as follows.

3.1.1. Literature review. In this phase, literatures that have been published on IEEE Explore and ITU.int in the last decade on ICT adoption in education are analysed to gain relevant information.

3.1.2. Explorative and confirmative analysis. This phase comprises of data collection using focus group discussion (FGD) method whose objectives are: (1) exploring main components of ICT adoption framework for secondary education and (2) gathering confirmation from some education stakeholders on the proposed ICT adoption framework alternatives for secondary school. Three groups of education stakeholders who are involved in this activity namely: (a) education content developer and secondary education specialist; (b) policy maker in education; and (c) principals of public secondary schools. The FGD participants (respondents) are selected using purposive sampling technique. At the end of this phase, based on judgment of the education stakeholders as the result of FGDs, the best alternative of the proposed ICT adoption framework for secondary education is selected. Data collecting instruments are video camera, audio recorder, and brief questionnaires.

3.1.3. Testing the proposed ICT framework. This phase comprises several activities including: (1) data collecting from samples of public secondary school principals using online survey technique; (2) data processing and analysis; and (3) developing ICT adoption model. In order to outreach respondents from various provinces, data collection is implemented using online questionnaires as instrument.

The link to the online questionnaire is emailed to the list of school principals in several provinces who are selected using systematic random sampling technique. Back checking process to the returned questionnaires is implemented to ensure reliability and validity of the collected data. Finally, some hypotheses about main variables that contribute to ICT adoption in secondary schools and association among latent variables in ICT adoption in secondary education are tested using statistical methods.

3.2. Data analysis

Data analysis is implemented using qualitative and quantitative data analysis techniques as follows.

3.2.1. Qualitative data analysis. The purpose of qualitative data analysis is to identify: (1) the main observed variables and candidate of latent variables that presumably contribute to the success of ICT adoption in secondary education, and (2) prior model of ICT adoption in secondary schools. Given qualitative data collected from literature analysis and FGD method, a set of observable variables are collected and categorized. Each category of observable variables is then labelled.

3.2.2. Quantitative data analysis. The main purpose of quantitative data analysis is to test hypotheses regarding the effect of each observed variable to the constructed latent variables, and the association among latent variables in the ICT adoption which are represented by prior models.

The results of hypotheses testing on the effect of each variable to its corresponding latent variable are used as basis for variable selection. Similarly, the results of hypothesis testing on the association among latent variables and linear model goodness-of-fitness in the structural equation model are used as basis for building ICT adoption model. Finally, the ICT framework model is derived from the best structural ICT adoption model. Quantitative analysis is conducted using Structural Equation Modelling [27] which combines several statistical analyses such as: factor analysis models, regression models, and complex path models.

After review the theories and cases, it shows that ICT adoption cases in Indonesia are similar from other developing countries. Then, the authors conducted Focused Group Discussion in three respondent categories groups (1) ICT developer who produce education ICT product with five years experiences in implementing to some schools, (2) ICT integrator who design ICT implementation in schools as project manager, and (3) school headmaster who implements ICT-based teaching and learning.

Group 1 conclude that there are general and specific ICT product which used in education. Common ICT product such as computer, internet, projector, etc, and particular ICT product is tools (hardware and software) who produced for teaching and learning purpose only such as LMS and LCMS. The particular one are often difficult to meet the requirement. ICT product that is used in schools should be in accordance with the curriculum applied. It is normal that finally they have their product is not aligned to the school process. So the schools involve teachers in designing the particular product ICT for teaching and learning, until deployment.

Group 2 conclude that they have difficulty in providing ICT support which ideally should be adopted by school effectively. The human resource composition of a school is the teacher whose main job is teach without any ICT skill requirement. This causes the supporting hardware and software is not sufficient, however, ICT skill of teachers should also be improved in order to achieve the expected goals. Enhancing ICT skills of teachers obviously need the support of the principal and sufficient funds. Wisely, teacher must also have motivation to improve themselves.

Group 3 explain that curriculum requires students to have diverse skills. This makes it difficult to achieve the learning process competencies expected from students. ICT reduces the limitations of teachers and students in exploring science. Limitation of learning is about observation learning object characteristics such as too small, too big, too far, too fast, too slow, etc. Learning content is easy to be managed.

Regarding to ITU framework and Components found from many sources, there are view angle like Figure 3 where ICT adoption components are mapped.

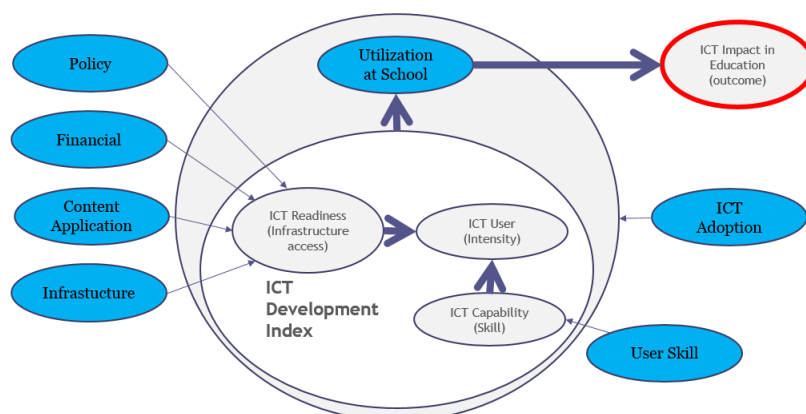


Figure 3. ICT adoption component mapping

Source: compiled from ITU framework and variable from literatures.

4. Results

From literature review, explorative/confirmative analysis, gathered are components and factors of ICT for Education found as shown at Table 1 and the relation shown at Figure 4.

Table 1. Component and factor of ICT for education

Components	Factors	Components	Factors
INFRASTRUCTURE	Availability of: Electricity TV/Radio Telecommunication Computer Internet Bandwidth Printer/Scanner/Fax Smart Device	UTILIZATION	Intensity of: Using infrastructure, application/content in teaching student and manage schools.
	Availability of: Computer System Administration System Learning System Learning Content System Learning Evaluation System		Applying: Rule Regulation Term and Condition Guidance
	Skill of: Basic computer literate Using Application/ Content in teaching and learning		Availability of: Finance source to support infrastructure, application/content and training for teacher.
APPLICATION		POLICY	
USER SKILLS		FINANCE	

From testing and data analysis, there are components relationship diagram can be seen in Figure 5, 6 and 7 where each component has weight contribution which calculated by using SmartPLS data analysis tools.

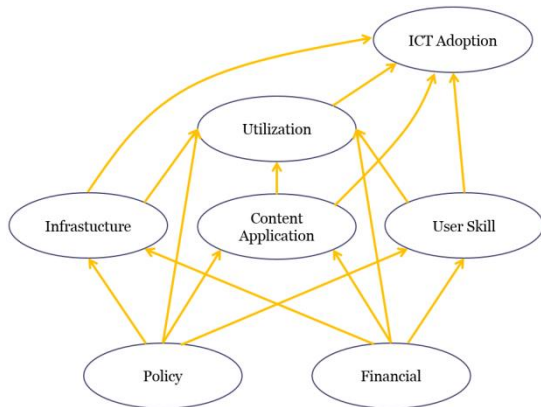


Figure 4. ICT adoption component's linkage from literature

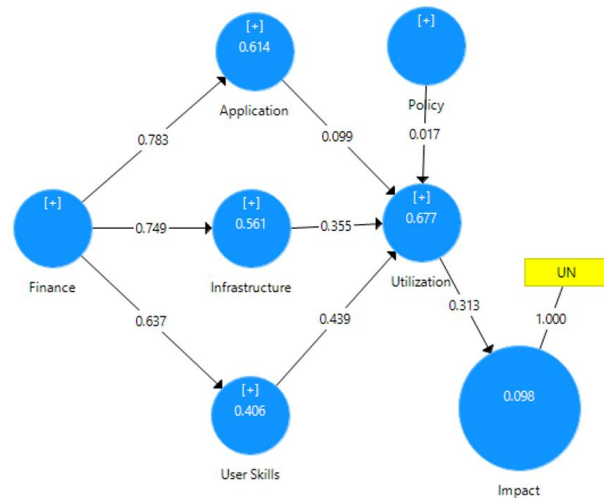


Figure 5. ICT adoption impact to variable of school's national examination score average

Data processed by SEM revealed several components such as: Infrastructure, Finance, Policy, Content, Utilization, and User Skills. After conforming the form and weight of relation, each component's contribution weight can be seen from how much the component affects another components. One of the result shows each component's contribution weight to impact school's national examination score component is described completely in Figure 5.

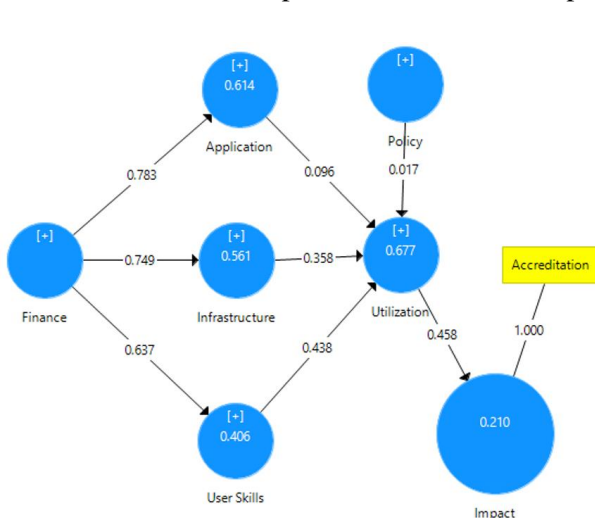


Figure 6. ICT Adoption impact to variable of school's national accreditation

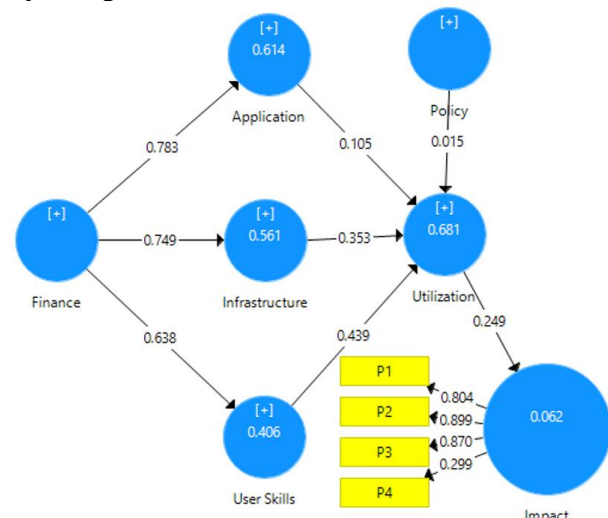


Figure 7. ICT adoption impact to variable of student's competition performance

Finance directly affects Infrastructure (0.749), Application (0.783) and User Skills (0.637). Whilst, Infrastructure (0.355), Application (0.099), User Skills (0.439) and Policy (0.017) directly affect Utilization. Since Utilization is the only one observed component affects to the impact, the result shows specifically that Utilization affects school's national examination impact about 0,313, affect school's national accreditation about 0.458, and affect student's competition performance (stated as P1, P2, P3, and P4) about 0.249. P1 until P4 represents number of student win the competition level sub-district, district, province and national.

Figure 6 and 7 are also conformable. The result indicates that Utilization can be executed after school has Infrastructure and User Skills. Whist Policy contribute Utilization least, and Financial give contribution much, so the proposed ICT adoption framework in education can be created like Figure 8.

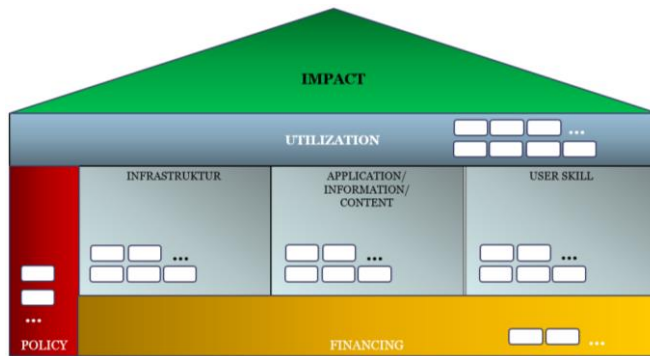


Figure 8. The proposed ICT adoption framework in education

5. Conclusion

Figure 8 shows ICT adoption impact is reached after schools utilized ICT by contribution from infrastructure and application existence, operated by user whose ICT skill is literate. Policy is support component since the weight is not significant, it means that policy is not considered as a primary key in order to utilize ICT in education. The study concludes that development of ICT adoption framework should consider components contribution weights among the components that can be used to guide the implementation of ICT adoption in education.

To get better work, the results need to be refined in the future to get more valid numbers of sample which wider or clustered in order to get the result more accurate.

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