Factors Affecting the Implementation of Smart Education in Indonesia: A Systematic Review

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Abstract. The educational progress of an area is determined by the way the government manages its education system. Smart education is a learning concept that utilizes 21st-century skills by following the latest technological innovations. Not all regions are able and ready to implement the concept. This study utilizes the Systematic Review method to identify what factors need to be considered in implementing smart education based on previous studies. The research resulted in five main interrelated aspects of all the factors found in previous studies, namely technological aspects, data aspects, H.R. aspects, organizational aspects, and cost aspects. By paying attention to all the factors from these five aspects, it will increase the level of success of the government in implementing smart education.

Keywords: Smart Education, Systematic Review, Factors Affecting

1 Introduction

Based on CEOWorld Magazine conducted research related to education in 2020, one of the results showed the ranking of the education system in Indonesia was at 70th out of a total of 93 countries studied [1]. The assessment was carried out from January to April 2020, when the world was at the beginning of the Covid-19 pandemic, by prioritizing aspects of quality and opportunity. The quality aspect is focused on the public education system, while the opportunity is focused on the school graduation rate [1]. The education system that has changed in a short time from face-to-face to online Learning has not been well anticipated by the government in Indonesia [2]. For example, teachers find it difficult to adapt the K-13 curriculum to the online learning system, teachers and students lack knowledge of distance learning technology, additional internet quota fees, and the additional work of parents in assisting children in Learning [3][4]. From Indonesia 2019 education statistics, the school graduation rate is also still lacking. For example, at the high school level which has been required by the government, the graduation rate has only reached 62.2% [5].

Gradually, several cities/districts in Indonesia have carried out digital transformation by implementing the smart city concept. According to Law Number 24 of 2014 concerning regional government, one of the six basic services prioritized in the smart city concept is education services, which can be implemented through the smart education concept [6][7]. The need for digital

transformation to improve the quality of the education system, which will continue into the new normal era, must be seriously considered by the government. The transformation carried out in the smart education concept does not only change the curriculum and learning methods offline to online, so the government must know what factors affect the implementation process so that all parties involved are institutions more prepared, but the transformation also runs smoothly, and the risk of failure can be avoided [8][9].

The purpose of this study is to make a summary of what factors need to be considered by local governments in implementing the smart education concept based on previous studies using the Systematic Review (S.R.) methodology. It is hoped that this research will become one of the references for the government in starting the development of the smart education concept in their area.

2 Theoretical Basis

2.1 Systematic Review (S.R.)

The Smart City (smart city) is a city concept where the community is able to utilize technological resources efficiently and intensively to increase economic growth and comfort of life [10][9] [11]. One of the services that must be developed in implementing the smart city concept is education services (smart education). Smart education itself is a learning concept that utilizes 21st-

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century skills, which is student-centred with the support of advanced and integrated I.T. infrastructure so that the learning process is more interactive, innovative, and comprehensive [9][8][12]. The novelty of technology used in the process and manufacture of learning products on the concept of smart education must be able to provide opportunities and access to proper education for all elements of society [8].

Some of the technologies used to support the application of the smart education concept based on the analysis of [13] are as follows.

1. Social Media, i.e. facebook, LinkedIn, Instagram, Wikipedia.
2. Collaborative Learning, several students work together to achieve something, solve a problem, or complete a project.
3. Mobile Learning, learning through smartphone media with the help of an internet connection.
4. Edutainment/Gamification, designed to entertain as well as educate. For example, a game that requires students/players to answer science questions.
5. Digital Pedagogy, the use of digital technology in the teaching and learning process by digitizing the subject matter.
6. Massive Open Online Course (MOOC), an online course that can be accessed by anyone.
7. Blended Learning, mixed Learning that involves online systems and face-to-face meetings.
8. Flipped Classroom, students get learning materials before class online and they take advantage of class time in a discussion.
9. Open Educational Resources (O.E.R.s), educational materials that are in the public domain or introduced under an open license. It can be a textbook containing a syllabus, assignment notes, projects, animations, and more.

Fig. 1. Technology that supports the implementation of Smart Learning [13].

2.2 Smart Education

S.R. approach is one of the methods used by researchers to refer to available research or research methodologies that are relevant to the topic area and research questions so that interpretation and evaluation can be carried out [14][15]. Research with the S.R. method aims to provide a more precise evaluation using a reliable, rigorous, and auditable methodology that is usually required in a study [14][15].

In the implementation of the S.L.R., there are three stages, namely: the first stage is an introduction, which includes the scope of determining research questions. The second stage is the process of determining search sources and selecting keywords. And the last stage is to determine the inclusion and exclusion criteria used to classify the type of research, then extract data from the selected research for further exploration [16].

3 Methodology

In presenting a literature review to identify factors that can influence the implementation of smart education, we will use the S.R. methodology based on research [17].

1. SLR Protocol, Mendefinisikan pertanyaan penelitian, sumber pencarian, kondisi pencarian, strategi pencarian, kriteria khusus, maupun kriteria yang dihindari.
2. Search for Literature, melakukan pencarian literatur pada sumber yang telah ditentukan.
3. Select Literature, Menyeleksi hasil pencarian literatur yang terkait dengan kata kunci pertanyaan penelitian.
4. Summarize Evidence, Menyimpulkan isi dari semua literatur yang telah dipilih.
5. Disseminate Result, menuliskan hasil penelitian ke dalam sebuah laporan karya tulis.

Fig. 2. Illustration of the S.R. process in the IS/IT domain [17].

3.1 S.R. Protocol

Based on the process in Figure 2, the research S.R. protocol can be defined as follows:

Table 1. Protokol SR.

S.R Protocol	Description
Research Question	What factors do local governments consider in implementing Smart Education
Source	<ul style="list-style-type: none"> - ACM Digital Library (http://portal.acm.org) - IEEEExplore (http://ieeexplore.ieee.org) - MECS Press (http://www.mecspress.org/) - Science Direct (http://www.sciencedirect.com) - SpringerLink (http://link.springer.com)
Search Terms	("Smart Education" OR "Smart Learning")
Search Strategy	<ul style="list-style-type: none"> • Step 1: Enter keywords into the search feature on the digital library portal. Then choose a publication year between 2016 and 2020. • Step 2: Declare the total search results by keyword as "paper found". • Step 3: Read the title of each paper found. If the title cannot identify the contents of the paper, continue reading the abstract. If the title and abstract align with the research objectives, then the paper will be downloaded for further investigation. The downloaded papers are called "candidate papers". • Step 4: The "candidate paper" will be studied to see its relevance to the research objectives. Relevant papers will be categorized as "selected papers".

3.2 Implementation

Search results from all sources by entering the appropriate keywords found 553 scientific papers. The paper was published between 2016 and 2020 and is related to Smart Education or Smart Learning. Table 2 shows the selection of data from each search source.

Table 2. Selection of data from each search source

Source	Paper Found	Candidate papers	Selected Paper
IEEEExplore	198	40	6
ACM	59	15	4
SpringerLink	14	12	6
MECS	14	6	3
ScienceDirect	74	9	1
Total	359	82	20

Of the 461 papers found, 20 selected papers were found. An illustration of the selection process is shown in Figure 3.

Fig. 3. Results of the process of searching for library sources

4 Results And Discussion

4.1 Literature Distribution

The literature search results published in the last five years, namely between 2016 and 2020, have produced 20 papers for further research. Figure 4 shows the distribution of the number of papers per year, which increases in 2019 but decreases again in 2020. The distribution of types of papers is shown in Figure 5, which shows there are nine journal type papers and 12 papers from conference results.

Fig. 4. Distribution of papers every year

4.2 Paper Selection

Based on SLR protocol, the purpose of this study is to find out what factors can affect the process of implementing smart education. Table 3 contains a list of selected references related to the implementation of smart education.

Table 3. Literature source.

S.I. D.	Title	Source	Year	Type
S1	Towards a Smart Learning [18]	ACM	2016	Conference
S2	Measuring Smart Education [19]	ACM	2018	Conference
S3	How Smart Are[20]	ACM	2019	Journal
S4	Smart School Guidance[21]	ACM	2019	Conference
S5	The future of [22]	ACM	2020	Conference
S6	ICT and internet [23]	IEEEExplore	2016	Conference
S7	Smart learning [24]	IEEEExplore	2016	Conference
S8	Edukas environment [10]	IEEEExplore	2017	Conference
S9	Smart education in Yunnan, China [25]	IEEEExplore	2017	Conference
S10	The Knowledge [26]	IEEEExplore	2018	Conference
S11	Factors considered[16]	IEEEExplore	2019	Conference
S12	Review on [27]	IEEEExplore	2019	Conference
S13	Smart Classroom[28]	IEEEExplore	2019	Conference
S14	Analyses of [29]	MECS	2018	Journal
S15	Rural Empowerment [30]	MECS	2020	Journal
S16	Five trends of[31]	Science Direct	2020	Journal
S17	A research framework of smart [12]	SpringerLink	2016	Journal
S18	Citizen experiences [32]	SpringerLink	2017	Journal
S19	Smart learning [33]	SpringerLink	2017	Journal
S20	Smart learning[34]	SpringerLink	2018	Journal
S21	Smart educational tools and learning [35]	Springer Link	2020	Journal

4.3 Factor Mapping

Based on the literature that has been collected, then mapping is carried out on each literature related to what factors need to be considered in implementing the smart education concept. The results of the process with the S.R. method contained many factors, the researchers

took the factors discussed by more than one reference. Mapping produces 17 factors as shown in table 4.

Table 4. Literature Mapping Influential factors and reference sources.

FID	Factor	Reference source
F1	Internet Network	S1, S2, S3, S4, S5, S6, S7, S8, S9, S10, S11, S12, S13, S14, S15, S16, S17, S18, S19, S20, S21
F2	Date Server/Cloud Computing	S1, S2, S4, S5, S6, S7, S8, S9, S12, S15, S17, S19, S20, S21
F3	Communication device	S1, S2, S3, S4, S5, S6, S7, S9, S11, S12, S13, S16, S17, S18, S19, S20, S21
F4	Physical classroom	S3, S4, S7, S8, S9, S10, S11, S12, S13, S14, S15, S16, S17, S18, S19, S20, S21
F5	Virtual Class (e-Learning)	S2, S4, S5, S6, S7, S8, S9, S10, S11, S12, S16, S17, S18, S19, S20, S21
F6	Trend Technology/ Application	S1, S2, S3, S4, S5, S6, S7, S8, S9, S10, S11, S12, S13, S14, S15, S16, S17, S18, S19, S20, S21
F7	Monitoring system (monitoring)	S5, S6, S7, S8, S13, S17, S21
F8	Data security and User privacy	S1, S2, S3, S5, S7, S8, S12, S15, S16, S18, S21
F9	Data and application integration	S1, S2, S4, S5, S7, S8, S9, S10, S11, S12, S13, S14, S15, S16, S17, S20, S21
F10	Source or material learning	S3, S5, S6, S7, S8, S9, S10, S11, S12, S13, S14, S15, S16, S17, S18, S19, S20, S21
F11	Lecturer (Teachers, Instructor)	S1, S2, S3, S4, S5, S6, S7, S8, S9, S10, S11, S12, S13, S14, S15, S16, S17, S18, S19, S20, S21
F12	Student	S1, S2, S3, S4, S5, S6, S7, S8, S9, S10, S11, S12, S13, S14, S15, S16, S17, S18, S19, S20, S21
F13	Application manager (admin, operator)	S1, S9, S15, S17, S21
F14	Model/framework smart education	S1, S3, S5, S6, S7, S8, S9, S10, S12, S13, S15, S16, S17, S18, S19, S20, S21
F15	Rules and policies	S1, S8, S9, S15, S16, S21
F16	Syllabus and learning models	S3, S8, S9, S10, S11, S12, S14, S15, S16, S17, S18, S19, S20, S21
F17	Financing	S5, S7, S15, S16, S21

The factors found can be categorized into 5 main aspects or factors, namely aspects of technology, data, human resources (H.R.), organization, and financing. Figure 6

shows the aspects that affect the implementation of smart education.

Fig. 6. Aspects that affect the implementation of smart educationof

4.4 Discussion

The order of ranking factors from the most important to the most important or most discussed by the reference is shown in Figure 7.

Fig. 7. Ranking factors that influence the implementation of smart education

The following is an explanation of the factors that influence the implementation of the smart education concept.

1. Internet network. It is an infrastructure that must exist in the smart education concept to access data in real time. Internet connection must exist in all areas to be implemented.
2. Communication devices. In the form of tablets, P.C.s, laptops, smartphones, or other devices that can be used to communicate in the learning process.
3. Technological trends. In the form of platforms or applications that have implemented the latest technological innovations, such as teleconference, big data analysis, gamification, artificial intelligence, and others.
4. Teacher. Teachers/lecturers/instructors must be actively involved in the concept of smart education, because they will design the syllabus, deliver materials, and evaluate learning outcomes. Teachers must have innovative ways of utilizing technology.
5. Students. Is a factor that is the main target and determinant of the success of an education system. It should also be noted that family or government support for the facilities needed by students. Not only communication tools, but also time, supervision, and guidance from parents.
6. Resources or learning materials. In the form of learning materials that have been prepared by the teacher. Apart from teachers, students can also access other learning resource materials from the internet to enrich their knowledge.
7. Integration of data and applications. Teachers/students can use the learning platform from various devices such as laptops, smartphones, and tablets to access the same data. Another benefit when a student changes schools, data integration will make it easier for the targeted school to access student data that already exists/filled in from the previous school.
8. Smart education model/framework. The preparation of this framework must consider many factors and be carried out before implementing smart education in a region. In research [12], there are three main elements that must exist in the smart education model, namely smart learning environment, smart pedagogies, and smart learners.
9. Virtual Class. Is a platform used to carry out the learning process, such as through e-learning or teleconference. This virtual class functions as a complement to meetings in real classes, but in certain circumstances, such as during the COVID-19 pandemic, it can be used as a substitute for physical classrooms.
10. Data Server/Cloud Computing. The learning process, especially what is done online, cannot be separated from the need for data storage. Cloud computing technology can increase efficiency and effectiveness in the data storage process, because an organization can hand over all maintenance and security to the provider.
11. Syllabus and learning models are used as a guide for teachers in carrying out learning activities. This strategy should include formal and informal Learning, both in the real world and in the digital world [12].

12. Physical classroom/lab. Although almost all learning needs can be accessed online, students still need direct interaction with fellow students or other humans. This classroom is in the form of a learning room with various I.C.T. facilities/media and laboratories used for practicum.
13. Data security and user privacy, can be a major problem if not managed properly. Can be anticipated by using single sign on (SSO) or entrusting system development and data storage to a provider that already has a good security reputation.
14. Monitoring system, is used to monitor the system, evaluate Learning, and anticipate if something unexpected or unexpected happens.
15. Rules and policies. The government's support and role as outlined in the rules or policies will be the initial capital for implementing smart education. Policies must involve all stakeholders involved to accommodate all aspirations and increase the active role of all parties.
16. Application Manager, in the form of an operator or from management in charge of managing systems and applications so that they run according to plan.
17. Financing is an important element in implementation, but in previous studies there were not many references that discussed financing. This element of financing includes not only costs managed by the government related to system development and implementation, but also costs for fulfilling supporting facilities/equipment charged to parents students.

5 Conclusion

Before implementing smart education, the government and all related parties need to pay attention to several things that can later become a determining factor for successful implementation. This research using the Systematic Review method has concluded several things related to these factors. Several factors that need to be considered include aspects of: (i) technology, (ii) data, (iii) human resources, (iv) organization, and (v) cost. These factors can be used as special attention for the government in implementing the smart education concept.

Further research is expected to be able to dig deeper into each of the influencing factors, so as to produce a more detailed picture and the impact of each factor.

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