Journal of Information Systems and Informatics
Vol. 4, No. 2, June 2022 e-ISSN: 2656-4882 p-ISSN: 2656-5935
http://journal-isi.org/index.php/isi Published By DRPM-UBD

Smart Campus Evaluation Monitoring Model Using Rainbow Framework Evaluation and Higher Education Quality Assurance Approach

Irfan Santiko[1], Anugerah Bagus Wijaya[2], Aulia Hamdi[3]

[1,2,3] Informatic Department, Computer Science Faculty, Universitas Amikom Purwokerto
[1] irfan.santiko@amikompurwokerto.ac.id, [2] anugerah@amikompurwokerto.ac.id,
[3] hamdi@amikompurwokerto.ac.id

Abstract

Education in the industrial era 4.0 experienced very significant changes. The role of information technology is a significant trend in education. Since the pandemic occurred at the beginning of 2020, almost all schools and even universities have indirectly demanded rapid changes in adapting to digitalization methods. It was also found that there were many obstacles during the pandemic in the implementation of information technology. The Indonesian state itself in education is still adapting and starting to develop with the existence of models of information technology approaches that can be implemented in academic activities, especially on campuses. Since 2010 it has been following the smart campus concept and model development. However, it was found to be varied due to the absence of a benchmark index in the campus's preparation, monitoring, and evaluation. Through the Rainbow Framework, this will be a solution in measuring the feasibility level through monitoring and evaluating the use of technology with a quality assurance approach. The results can be seen from the components that have been built using the calculation model for the quality of technology education in Indonesia.

Keyword : Monitoring Evaluasi, Smart Campus, Rainbow Framework

1. INTRODUCTION

The smart campus is a trend in of school technology today. Technology is increasingly being relied on in learning patterns. Many technological innovations are used, such as Internet or Things, Artificial Intelegence, Augmented & Virtual, Cloud, and the like [1] [2] [3]. Information system needs such as accuracy, relevance, and timeliness rely heavily on information technology. The field of education also requires such an information system. The school is an

educational environment that using a vital role in realizing the progress of a teritorial. All countries are racing to develop technology which is growing very fast [4] [5]. In the year 2010, it was known as Smart University. [6] [7] [8]. Universities are not only in the process of academic activities; on the management side, but even the campus outputs also cannot be separated from the use of information technology such as in new alumni tracking, selection processes, accreditation, payments, student admissions, and many more [9].

Smart campus comes from an academic system that uses technology and the internet as instruments. A smart education or an innovative university is expected to be a campus that can educate students with a system managed by informatic development [10]. This does not mean that a smart education is a campus consisting of bright students or teaching staff who can educate their students. However, a smart campus is a campus that combines, and implements the teaching and learning process using information technology [11]. So that all systems that support the teaching and learning process also use information technology. Implementing a smart education makes all campus elements require that they are connected, starting from lecturers, employees, students and other parts of the campus environment. [12] [13] [14]. One example of the application is using the Campus Academic System to use student lecture data to pay fees and the campus library. A smart campus certainly makes the education environment smart so that it will improve the quality, starting from staff, lecturers, students and campus management [15] [13] [11].

Practitioners have created many information technology products to support the world of education [16] [17] [18]. Call examples such as the Academic Information System, e-Office, Payment Gateway, Push Notification, and even the campus parking area cannot be separated from information technology products [19]. The current most trending technologies from academia, such as Artificial Intelligence, the Internet of Things, and Big Data, have become the standard size model in higher education. Although not all colleges use or even only some of the technology is used [20]. A smart campus itself is a combination of smart elements, which include five things: Smart Technology, Smart Governance, Smart Environment, Smart Service, and Smart Policy [21]. The elements are further grouped into six components based on developments for sustainability with an internal campus approach, including smart microgrid, smart utility, resource management, improved service, people management, and educational service [22].

p-ISSN: **2656-5935** http://journal-isi.org/index.php/isi e-ISSN: **2656-4882**

2. METHOD

In this paper, the author uses two methods: first, a literature review is carried out through an existing model, then processed in bibliometric analysis data using R Studio. Second, designing a new model with another approach, namely a combination of a rainbow framework with campus quality assurance.

2.1 Literature Review

2.1.1 Smart Campus

To determine the focus of the study in this paper, several previous studies were referred to in the last five years, starting from 2016 to 2021. The keyword used in obtaining this reference is Smart Campus which is taken from the source of Scopus Indexing Research. Obtained 92 documents, both journals and books, with an average citation per the year of 2776. The results of observations on the topic of smart campuses can be seen in figure 1 below :

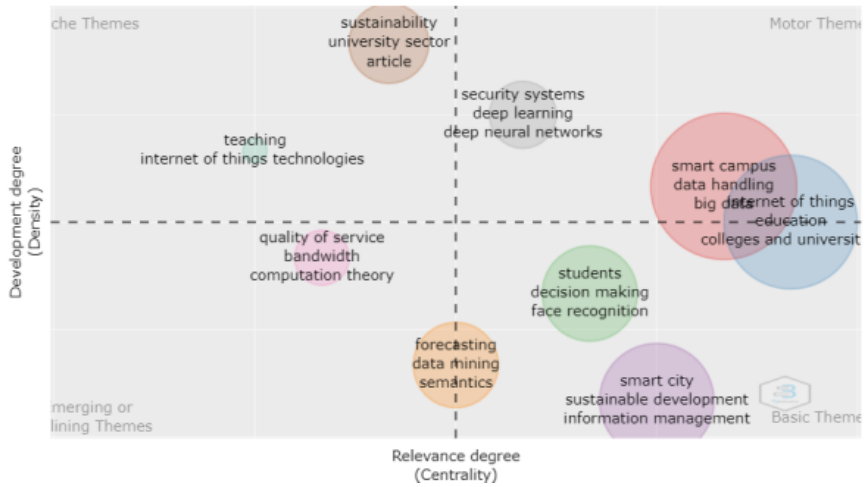

Figure 1, Density of Research

Looking at the pattern in Figure 1, it can be seen that the themes that appear most often are the smart campus, data handling, big data, IoT, Education, and college and university themes. These themes develop and are interrelated with each other. This means that the discussion of the smart campus theme cannot be separated from the development of the technology theme. Suppose it is related to the quality service theme. In that case, it is still quite far away, which means that the opportunity to bring the smart campus theme and its technology closer to the quality of both performances, model and evaluation monitoring is quite

p-ISSN: **2656-5935** http://journal-isi.org/index.php/isi e-ISSN: **2656-4882**

significant. None other than the goal is to enter the themes leading to the sustainable development of the smart campus in the coming year. Then the development and journey of the topic itself can be seen in the following figure 2.

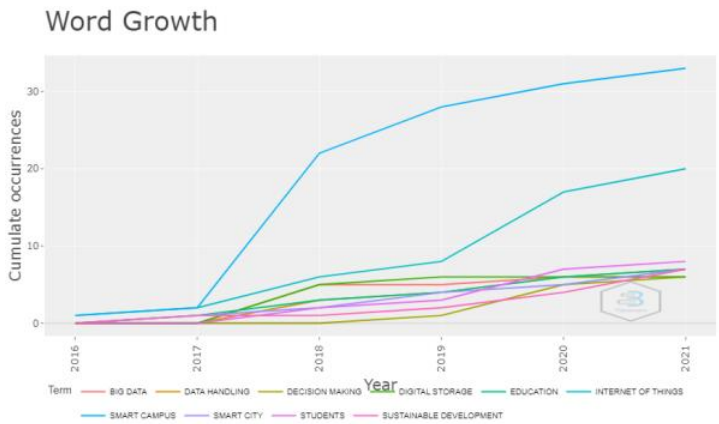

Figure 2, Topic development.

From 2016 to 2021, the topic of smart campuses has experienced a significant increase. Followed in 2017, many began to study IoT technology. IoT in 2019-2021 has increased significantly and is almost following/approaching the smart campus theme. This means that the smart campus theme itself is still an issue that continues to be discussed, and followed below is the discussion of the technologies that support it. Observing the issues related to studies that touch on monitoring and evaluation for the quality itself is still not visible. What can be seen is the theme of sustainable development, which has only begun to be discussed in 2020. In the graph, it is clear that the issue of smart campuses continues to be discussed but related to the technology that supports it, it still looks relatively flat. This can be triggered because there is no quality measurement; therefore, it is very likely to get closer to the quality issue in the sustainability of the smart campus itself.

2.1.2 Quality Assurance

Quality Assurance Unit is a quality assurance system for the implementation of Indonesian university, which is carried out through 3 sub-systems, namely: (i) Higher Education Database or known as the National PDPT, which is a systemic activity of collecting, processing, and storing data and information about the implementation of higher education in all universities. Higher education by the Directorate General of Higher Education to oversee the implementation of higher education by the Government, (ii) the Internal Quality

Assurance System or known as SPMI, namely the systemic quality assurance of higher education by universities and (iii) the External Quality Assurance System in the form of systemic activities to assess the feasibility of programs and universities higher education by the National Accreditation Board for Higher Education or independent institutions outside universities recognized by the government to oversee the implementation of higher education for and on behalf of the community as a form of public accountability. The SPMI instrument itself is divided into four instruments, namely, Quality Policy, Quality Documents, Quality Manuals, and Quality Standards [23].

The aim is to maintain and improve the quality of higher education in a sustainable manner, which is run by a university internally, to realize the vision, and to meet the needs of stakeholders through the implementation of the "Tridharma of Higher Education." Achievement of quality assurance objectives is carried out through SPMI to obtain accreditation through SPME by an Accredited department or an independent institution recognized by the Government. [24].

2.1.3 Rainbow Framework

The Rainbow Framework (TRF) is a framework developed by Better Evaluation (betterevaluation.org) of various methods and processes commonly used in Monitoring and Evaluation (Monev) activities. These methods and processes are organized into seven groups marked with different colors to make it easier for users when using this framework in the Monev process. The TRF evaluation framework can help plan M&E activities in stages and choose a combination of methods and processes to help complete activities. In addition, TRF provides a choice of "approaches" that refer to a package of methods and processes. One example of this approach is the "Randomized Controlled Trials" (RCTs) method, a combination of a random sample, control group, and standardized indicators and measurements.

Figure 3, The Rainbow Framework (Better Evaluation 2020) [25].

p-ISSN: **2656-5935** http://journal-isi.org/index.php/isi e-ISSN: **2656-4882**

2.2 Modeling

2.2.1 Topic of Model

In the analysis that has been done in the literature review analysis, a "fishbone" pattern is then made to determine the sustainability of the current research topic. Suppose you look at the results of the previous analysis. In that case, you can describe the positions and opportunities that can make updated in the discussion of this paper can be seen in Figure 4.

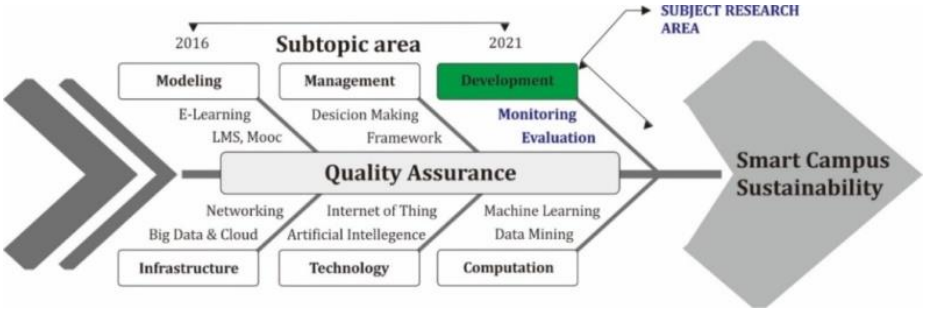

Figure 4, Fish Bone Diagram

Figure 4 shows that there are two different sides between the subtopic areas, namely the top, which is included in the information system area, and the bottom is the informatics area. The two subtopics were then approached using Quality Assurance, whose ultimate goal was the domain of the topic of smart campus sustainability. In the green section, the new sub-area, namely the Monitoring and Evaluation Development sub-area, is the information system area developed in this research.

2.2.2 Information System Model

In this information system model, two models are designed to support the monitoring and evaluation platform on the smart campus. The first model is for the basis of information quality and the second model is for the information system platform. For modeling the first information system obtained the following model:

Figure 5, Quality information model

From figure 5, it is known that the quality of the information system that has

been used so far was developed on the "SMART" side, which means that relevance must be based on intelligent data. Accuracy also needs to target knowledgeable data; then, the precision side must be able to position the data perfectly.

After the information concept, then design a platform model as a guide in building the system later, the following platform guide model is designed:

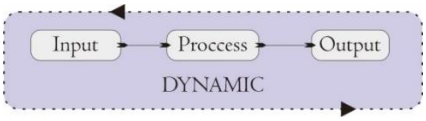

Figure 6, Platform information system model.

From figure 6, it can be explained that building an information system must have dynamic elements. The purpose of this dynamic element is that everything needed regarding data can be obtained without human intervention. So this system will run side by side with artificial intelligence technology.

3. RESULT & DISCUSSION

To begin with, a research phase is needed. The flow pattern is described by a Sequence flowchart diagram model divided into 4 phases with ten activities. The following is the direction of the phase to be carried out:

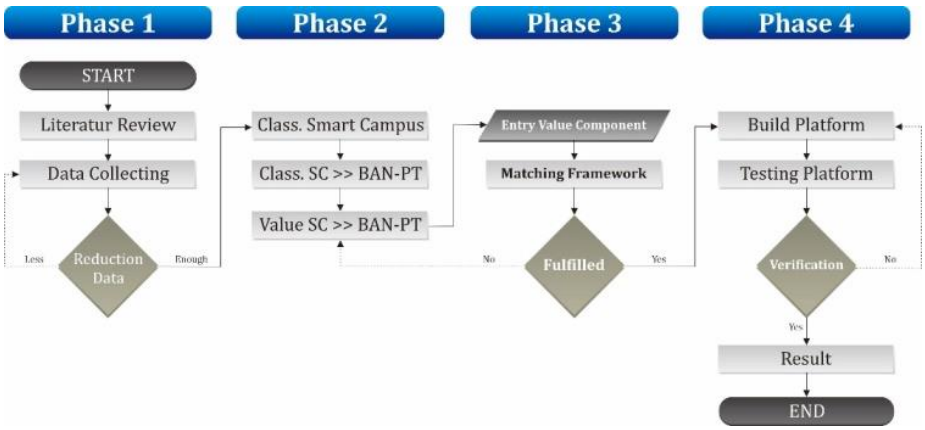

Figure 7, Phase research

a) The researcher determines the research objectives based on the existing

literature review. Determining this goal uses the Systematic Literature Review (SLR) technique. The data obtained is then collected to be processed simply through a reduction (simplification) process. The groups of related statements that can be used as the basis for the parameters of the questions to be asked are as follows:

P1: Knowledge of information technology in the campus environment.

P2: The use of platforms, media, and technology environment.

P3: The performance of the existing system in the campus environment.

P4: Functions of Platform, Media, and Technology in the campus environment.

If you are going to use a questionnaire, you need a group of answers that will be based on the previous related statement; the modeling is as follows:

Q1 : Yes/No/Neutral ➔ P1

Q2 : Easy/Difficult ➔ P2

Q3 : Very Nice/Nice/Poor ➔ P3

Q4 : Relevant/Irrelevant ➔ P4

ll information on the questionnaire rule (Q) will be calculated using the average notation formula, so it will be

$$Qa = \frac{1}{n}(q1 + q2 + \cdots + qn) \quad (1)$$

Sigma Notation is :

$$Qa = \frac{1}{n}\sum_{i=1}^{n} qi \quad (2)$$

Information :

Qa = mean

Qi = sample value n-i

n = sample accumulated

b) After the objectives are determined, start taking data samples using questionnaires, interviews, and observations on campus. If the results of data simplification have arrived and are declared sufficient in the first phase, then the next step is to make approaches by grouping criteria. The first criterion is the approach between the conclusions in the P1-P4 statements in the smart campus component scheme.

c) After the data is obtained, the data is reduced or simplified based on the functional needs of the research objectives.

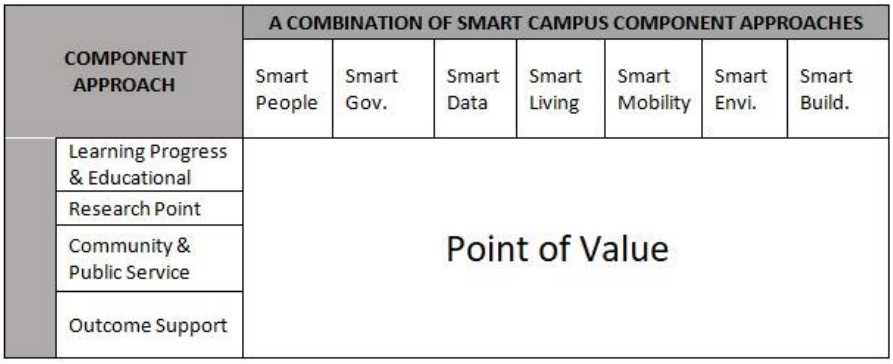

Figure 8, Matrix of data reduces for mapping component

d) After the data is simplified, the classification is carried out to be included in the smart campus component.

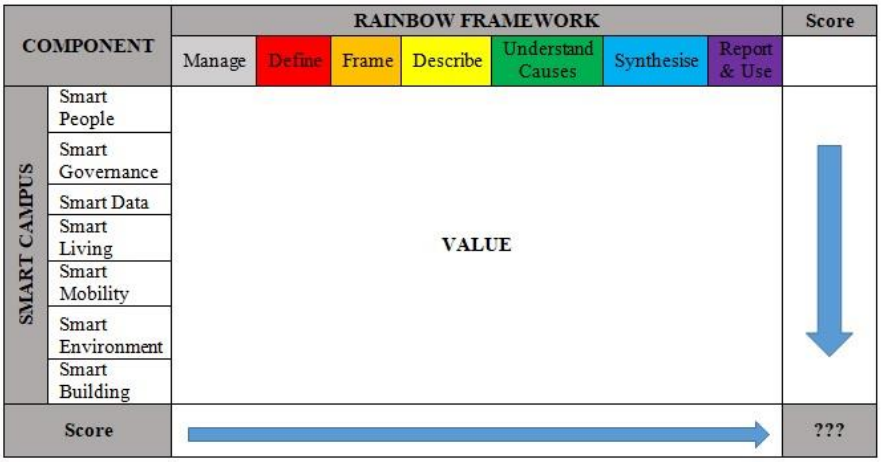

Figure 9, Mapping data to Rainbow Framework

e) After the components are followed, the assessment components determine the value parameters that can be used as standards in the Smart Campus component.

f) If the parameter values have been formed, then the monitoring system evaluation is designed through a sample using the Rainbow Framework as an M&E indicator and a Pre-Alpha Testing trial.

g) If the entire process has been fulfilled, all components and algorithms are packaged into an information system platform using website-based technology. When used by universities, it can be more dynamic. The description of the flow is still a superficial depiction. Then the users

themselves will be described using a use case diagram as follows:

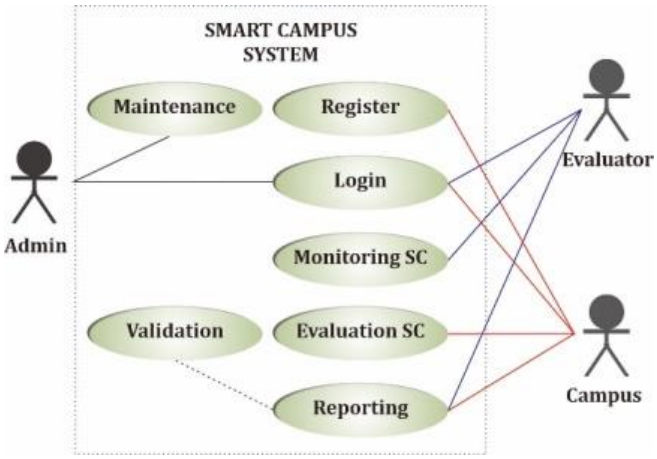

Figure 10, Usecase smart campus application

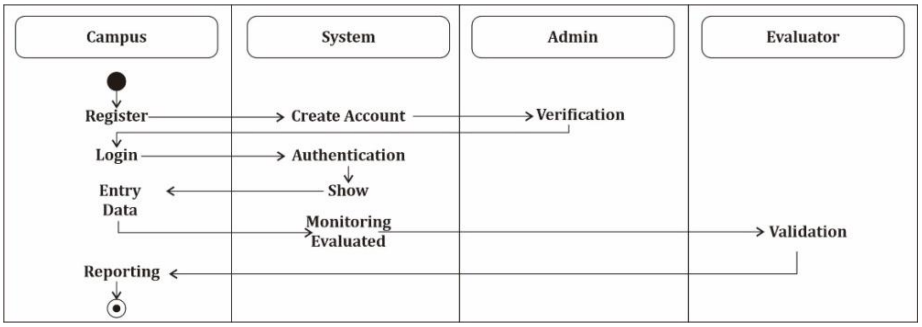

Figure 11, Activity model smart campus.

h) If the platform has been successfully built with all the completeness of the material, then further testing is carried out directly on the object of research, namely in universities using the Alpha Testing technique.
i) After the assessment is obtained, the following process is to analyze the results and verify the results. In addition, Post-Alpha Testing is also carried out, which aims to conclude the results that have been achieved.

4. CONCLUTIONS

From the results of the previous discussion, several conclusions can be drawn, including: First, the Rainbow Framework is a unique platform to measure the level of technical feasibility on a campus, which is considered relatively easy and accurate. Second, the quality approach on campus makes measurements easier

because it follows the conditions of the campus itself. Third, in building an information system on campus, one should pay attention to the dynamic pattern that is currently a trend in the world of industrial revolution technology. The technology that currently makes campuses into the smart group is that it is inevitable that they have Artificial Intelligence, Big Data, and Internet of Things technology. The technology that uses these three trends will become a superpower technology on the campus.

REFERENCES

[1] I. Martínez, B. Zalba, R. Trillo-Lado, T. Blanco, D. Cambra, and R. Casas, "Internet of things (Iot) as sustainable development goals (sdg) enabling technology towards smart readiness indicators (sri) for university buildings," Sustain., vol. 13, no. 14, 2021, doi: 10.3390/su13147647.

[2] N. F. Awang, A. F. I. M. Zainudin, S. Marzuki, S. N. Alsagoff, T. Tajuddin, and A. D. Jarno, "Security and Threats in the Internet of Things Based Smart Home," Lecture Notes on Data Engineering and Communications Technologies, vol. 72. Springer Science and Business Media Deutschland GmbH, National Defense University of Malaysia, Kuala Lumpur, Malaysia, pp. 676–684, 2021, doi: 10.1007/978-3-030-70713-2_61.

[3] B. Wu, R. Hao, H. Li, Q. Chai, and Y. Wang, "Research on Intelligent Campus System Design Based on BIM & VR/AR Technology," 2021, vol. 1885, no. 5, doi: 10.1088/1742-6596/1885/5/052050.

[4] A. AlAjmi, "Artificial Intelligence and Smart Universities," Studies in Computational Intelligence, vol. 935. Springer Science and Business Media Deutschland GmbH, Box Hill College Kuwait, Safat, 29192, 13152, Kuwait, pp. 295–310, 2021, doi: 10.1007/978-3-030-62796-6_17.

[5] M. A. A. Maidin et al., "Design Campus Map Using OpenStreetMap Digital Software." Springer Science and Business Media Deutschland GmbH, Department of Civil Engineering Technology, Faculty of Engineering Technology, Universiti Tun Hussein Onn Malaysia, Muar, Pagoh, Johor, 84600, Malaysia, pp. 113–129, 2021, doi: 10.1007/978-981-16-0742-4_8.

[6] S. Zakir, S. Defit, and V. Vitriani, "Indeks Kesiapan Perguruan Tinggi dalam Mengimplementasikan Smart Campus," J. Teknol. Inf. dan Ilmu Komput., vol. 6, no. 3, p. 267, 2019, doi: 10.25126/jtiik.201963986.

[7] Z. Liu, "Planning and Practice of Smart Campus in Higher Vocational Colleges from the Perspective of Education Informatization 2.0," 2021, pp. 497–500, doi: 10.1109/ICBDIE52740.2021.00119.

[8] T. Omotayo, A. Moghayedi, B. Awuzie, and S. Ajayi, "Infrastructure elements for smart campuses: A bibliometric analysis," Sustain., vol. 13, no. 14, 2021, doi: 10.3390/su13147960.

[9] B. V. A. N. S. S. Prabhakar Rao and R. K. Singh, "Disruptive intelligent system in engineering education for sustainable development," Procedia Comput. Sci., vol. 172, no. 2019, pp. 1059–1065, 2020, doi: 10.1016/j.procs.2020.05.155.

[10] M. Musa, M. N. Ismail, and M. F. M. Fudzee, "A survey on smart campus implementation in Malaysia," Int. J. Informatics Vis., vol. 5, no. 1, pp. 51–56, 2021, doi: 10.30630/joiv.5.1.434.

[11] S. Ahmed and T. Mazri, "Smart Campus Ibn Tofail Approaches and Implementation," vol. 237. Springer Science and Business Media Deutschland GmbH, Ibn Tofail University, Kénitra, Morocco, pp. 549–560, 2022, doi: 10.1007/978-981-16-3637-0_39.

[12] P. Purwanto and U. Diponegoro, "SUSTAINABLE INDUSTRY 4.0 Industry 4.0 for Sustainable Development," no. September, 2021, doi: 10.13140/RG.2.2.29486.64322.

[13] V. N. Hoang, P. Le Thanh, L. O. T. My, L. C. Vinh, and V. T. Xuan, "Towards a Novel Architecture of Smart Campuses Based on Spatial Data Infrastructure and Distributed Ontology," vol. 296. Springer Science and Business Media Deutschland GmbH, Can Tho University, Can Tho, Viet Nam, pp. 662–673, 2022, doi: 10.1007/978-3-030-82199-9_45.

[14] W. Hidayat, M. Hendayun, A. S. Sastrosubroto, R. Hidayat, and S. Haris, "Developing Smart Campus Readiness Instrument Based on Pagliaro's Smart Campus Model and Smart City Council's Readiness Framework," 2021, vol. 1783, no. 1, doi: 10.1088/1742-6596/1783/1/012051.

[15] S.-A. Pupiales-Chuquin, G.-A. Tenesaca-Luna, and M.-B. Mora-Arciniegas, "Proposal of a Methodology for the Implementation of a Smart Campus," vol. 236. Springer Science and Business Media Deutschland GmbH, Departamento de Ciencias de La Computación y Electrónica, Universidad Técnica Particular de Loja, San Cayetano Alto y Marcelino Champagnat S/N, Loja, Ecuador, pp. 589–602, 2022, doi: 10.1007/978-981-16-2380-6_52.

[16] M. A. Carlos-Mancilla, L. F. Luque-Vega, H. A. Guerrero-Osuna, G. Ornelas-Vargas, Y. Aguilar-Molina, and L. E. González-Jiménez,

"Educational mechatronics and internet of things: A case study on dynamic systems using meiot weather station," Sensors (Switzerland), vol. 21, no. 1, pp. 1–21, 2021, doi: 10.3390/s21010181.

[17] D. Hou, "Exploration and Practice of the Joint Operation Model of Campus Network in Border Universities," vol. 1385 AIST. Springer Science and Business Media Deutschland GmbH, Information Department, West Yunnan University, Lincang, Yunnan 677000, China, pp. 715–722, 2021, doi: 10.1007/978-3-030-74814-2_100.

[18] F. Maciá Pérez, J. V Berna Martínez, and I. Lorenzo Fonseca, "Modelling and implementing smart universities: An it conceptual framework," Sustain., vol. 13, no. 6, 2021, doi: 10.3390/su13063397.

[19] D. Al-Fraihat, M. Joy, R. Masa'deh, and J. Sinclair, "Evaluating E-learning systems success: An empirical study," Comput. Human Behav., vol. 102, no. August 2019, pp. 67–86, 2020, doi: 10.1016/j.chb.2019.08.004.

[20] Muhaimin, Asrial, A. Habibi, A. Mukminin, and P. Hadisaputra, "Science teachers' integration of digital resources in education: A survey in rural areas of one Indonesian province," Heliyon, vol. 6, no. 8, p. e04631, 2020, doi: 10.1016/j.heliyon.2020.e04631.

[21] Z. Y. Dong, Y. Zhang, C. Yip, S. Swift, and K. Beswick, "Smart campus: definition, framework, technologies, and services," IET Smart Cities, vol. 2, no. 1, pp. 43–54, 2020, doi: 10.1049/iet-smc.2019.0072.

[22] A. Eltawil, N. A. Mostafa, and Y. Matsushita, "Toward a Smart and Sustainable Campus: Future Vision, Opportunities, and Challenges," Advances in Science, Technology and Innovation. Springer Nature, Egypt-Japan University of Science and Technology, Alexandria, Egypt, pp. 233–242, 2021, doi: 10.1007/978-3-030-63567-1_20.

[23] Kemenristek, "Buku V Pedoman Penilaian Borang dan Evaluasi diri APTTJJ," in Badan Akreditasi Nasional Perguruan Tinggi, BAN PT, 2017.

[24] BAN-PT, "Akreditasi Perguruan Tinggi Kriteria dan Prosedur 3.0," Badan Akreditasi Nas. Perguru. Tinggi, p. 4, 2019.

[25] Better Evaluation, "Rainbow Framework," in Better Evaluation, 2019, p. 12.