

Development of Smart Campus Model

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Abstract— The challenges of higher education in the era of industrial revolution 4.0 are global competition and technological progress. Universities must be able to adapt to the fourth industrial revolution to be competitive and recruit new students in the face of such fierce competition. Universities in Indonesia must build a smart campus if they want to become more competitive. Before implementing a smart campus, it is necessary to build a smart campus model that becomes a reference for universities to implement smart campuses. The Smart Campus model created will refer to the Garuda Smart Campus Model and be integrated with the Higher Education model and the Smart System model can be a reference for universities to simulate the Smart Campus that will be implemented and can be the foundation for measuring the intelligence level of campus so that it can be a reference for colleges to simulate the Smart Campus that will be implemented.

Keywords—smart campus, smart campus model, smart system

I. INTRODUCTION

Currently, the term "smart" is widely used in the field of Information Technology as a smart system for smart building systems, smart city systems, and even smart campus systems, smart means "using a built-in microprocessor for automatic operation" which means a device that has a processor to carry out its operations.

Smart, according to Jason [1] is being able to make changes in response to changing situations.

Avaya, a multinational technology corporation, defines a smart campus as one that allows "engagement" from administrators to professors and students to connect with learning experiences anytime and anywhere, according to Modern Education Experience. [2].

Avaya recommends putting in place key pieces, including smart network infrastructure, smart devices like video cameras and door locks, smart mobile devices, and intelligent applications, to create a smart campus. This understanding of the term "smart campus" implies that a "smart" campus is defined by the use of "smart technology." Unlike in the notion of a smart city, 'engagement' in the establishment of a smart campus does not assume a user role; rather, it is a function facilitated by smart technology. [2]

A smart campus is imagined as a system that can provide answers to student questions that can be answered quickly using chatbots applications, student admission applications can be processed online within 1x 24 hours. Lectures can be done online without place restrictions by using the Learning

Management System. This can be an advantage for institutions that implement smart campus systems.

The challenge for higher education today is to link the industrial and educational worlds to build a super-smart society and to develop work graduates with the abilities required by industry as well as the ability to change with the times. The quality of graduates generated as a result of the challenges of the fourth industrial revolution, particularly global competitiveness and technical innovation, is a better indicator of a university's success or failure. To survive in the face of such fierce competition, universities must be able to adapt to the fourth industrial revolution to boost competitiveness against competitors and attraction for potential students [3].

Therefore, by implementing a smart campus, it is hoped that universities will not experience difficulties in improving the quality of universities, achieving the performance of the three pillars of higher education (outcome-based accreditation), increasing competitiveness, and excellent international outlook, full capacity because the institution offers a learning experience. digital which is an added value for the institution.

Currently, the implementation of a smart campus has been carried out by the University of Rome, Italy [4]. According to Pagliaro, a campus is similar to a small city in various ways, including the diversity of services, users, activities, and linkages. Furthermore, colleges and cities face similar issues and challenges, including environmental effects, management, and organizational issues, internal and external transportation and infrastructure, low efficiency, and a lack of fundamental services and features, all of which lead to user discontent. As a result, the smart city model may be easily adapted to a smart campus model.

The Spanish University of Malaga has also implemented a smart campus [5]. Fortes [5] said the "Smart-City" concept aims to efficiently manage urban areas, along with their resources and assets. information and communication technology (ICT) and the Internet of Things (IoT) paradigms are used to support this strategy. The relevance of telecommunication technology is demonstrated by smart cities' dependency on connection, which is as significant to the sensing and processing activities as it is to the sensing and processing activities themselves.

Campuses are their own "little town," with huge potential for advances in governance, sustainability, and learning in

8 terms of energy and water efficiency, emissions, mobility, health and well-being, nature, and education.

In Malatji's research [6], the University of Johannesburg (UJ) was used as a case study for smart campus implementation

Smart Campus research with a different approach was developed by MIT and Microsoft made the iCampus model used at MIT [1] [7] [8]

The primary purpose of constructing iCampus is to improve the student learning experience from beginning to end. In the middle of university rivalry, the difference is required, thus an effective framework must be developed to maximize student potential while also advancing the goal of increasing learning quality. [7].

5 In Indonesia, the smart campus model was developed by Smart City and Community Innovation Center (SCCIC) who created a smart campus model named the Garuda Smart Campus Model (GSCM).

Implementation of a smart campus is something that must be done by universities in Indonesia to increase the competitiveness of the university. Before implementing a smart campus, it is necessary to have a smart campus model that becomes a reference for the university to implement a smart campus.

This paper introduces the most effective smart campus model today by integrating the concept of higher education in Indonesia with a smart system into the Garuda Smart Campus model.

II. RELATED WORK

A. Campus Model

According to the Indonesian Dictionary, a model is a pattern (example, reference, variety, etc.) of something to be made or produced.

Universities in Indonesia are one form of higher education in addition to academics, institutes, polytechnics.

The campus can be defined in two ways, according to Merriam-Webster Dictionary. The first are a university, college, or school's grounds and buildings. A university is regarded as an academic, social, and spiritual entity in the second case.

A university, according to Merriam-Webster Dictionary, is an institution of higher learning that provides teaching and research facilities and is allowed to award academic degrees.

From the above definition, the campus has a broader meaning than the university which does not only talk about academics but includes buildings and other educational facilities.

In Indonesia, there are three types of universities: those that offer full online learning, those that offer hybrid learning, and those that offer full offline learning on campus. Because the covid19 pandemic has forced 12 offline learning on campus to be discontinued to reduce the spread of the covid-19 virus, the campus model used in this study was hybrid learning; therefore, the environment will still be included in this model for handling building

facilities. As a result, the campus model is not derived from the smart city model in this hybrid learning.

1 Law No. 12 of 2012 concerning Higher Education in Indonesia in Article 5 explains the objectives of Higher Education, namely:

1 a. developing the potential of students to become human beings who believe and fear God Almighty and have a noble character is healthy, knowledgeable, capable, creative, independent, skilled, competent, and cultured for the benefit of the nation;

b. the production of graduates who master the branches of Science and/or Technology to fulfill the national interest and increase the competitiveness of the nation;

2 c. the production of Science and Technology through Research that pays attention to and applies the values of the Humanities to be useful for the progress of the nation, as well as the progress of civilization and the welfare of mankind; and

d. the realization of community service based on reasoning and research work that is useful in advancing the general welfare and educating the nation's life.

So, from law no 12 of 2012, a campus is a place where knowledge becomes value using the value tree metaphor described in Figure 1. The Higher Education Cycle has five aspects to be sustainable, namely:

1. Ideas and hypotheses serve as the seed.
2. Learning, research, and innovation are fertile gardens (trees).
3. Knowledge, skills, and attitudes are all examples of useful fruits.
4. Product is the result of the fruit used by the community.
5. Products generate value and wealth

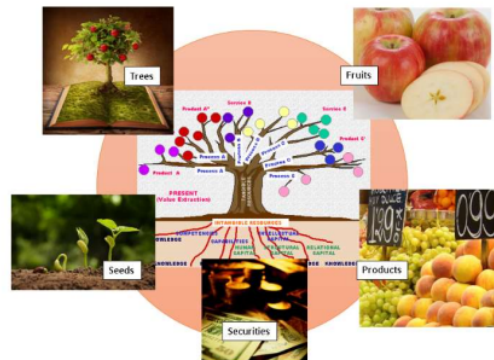


Fig 1 Model Campus: Value Creation From Living Knowledge

Value creation for the campus is how to integrate learning, research, and community service into products that are produced from fruits so that they can become a wealth of value and finance that continues to grow.

B. Smart System Model

A system is a collection of interacting or interconnected elements that work together to achieve common goals. Each component of a system has its own goals, but when these parts

work together, the individual goals and the system's common goals are balanced

A campus is a system consisting of sub-systems such as the academic system, learning management system, payment management system. And these sub-systems are interconnected to realize the goals of the university.

According to Romero [9], The term "smart system" refers to a system that allows users to get the most out of its services. A smart system, according to another definition, is a system that solves issues rationally, as humans do, and can reflect on and explain how it solves and justifies anything.

Research from Kalluri [10] divides the dimensions of the smartness system into 4 dimensions, namely:

1. Integration Level Dimension.

At the physical level, it represents the level of integration of sub-systems, components, and devices, as well as the interchange of information and knowledge among them.

2. Dimensional Real-time feedback control.

A characteristic of a control system that permits a feedback loop to be closed in real-time. This is a critical element of CPS for ensuring safe and effective operation at the appropriate moment.

3. Dimensions of Level of Automation.

The extent to which system functions previously done by human operators have been partially or completely replaced. In a Cyber-Physical System (CPS), data is collected via sensors, evaluated by computers, and decisions are made either automatically or by humans, resulting in actions being carried out via actuators.

4. Dimensions Level of cooperative control.

Describe how sub-systems, components, and devices are connected, shared information, and coordinated to achieve overall system goals.

The dimension of smartness that will be taken in this research is the dimension of the level of system automation. The core process of a smart system based on the level of automation consists of perception, planning, decision, action, learning.

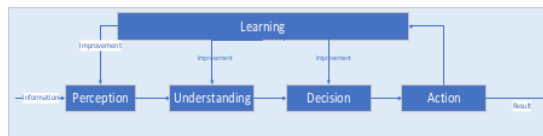


Fig 2 Smart System Model

TABLE 1 DEFINITION CHARACTERISTIC SMART SYSTEM.

Process	Definition
<i>Perception</i>	The ability of the system to gather meaningful and relevant information on its own.
<i>Understanding</i>	The process of converting data into information that can be used to

	generate alternative plans of action for the next step.
Decision	Ability to choose the best answer from a set of options based on a variety of criteria
Action	An implementation generates a result.
Learning	The ability of the system to improve its cognitive skills through data analysis.

III. APPROACH SMART CAMPUS MODEL

Because campus is a place for cultivating knowledge into value and a campus is a system consisting of several sub-systems, the model that will be used is a model that accommodates the model of the campus and the model of the smart system so that a campus can be called a smart campus.

In many ways, the university campus represents a small independent city, such as the variety of functions, users, activities, and connections. Furthermore, universities and cities face similar issues and challenges, such as environmental impact, management, and organizational issues, internal and external mobility and infrastructures, low efficiency, and a lack of fundamental services and features, resulting in user dissatisfaction. As a result, the Smart City model lends itself well to transformation into the Smart Campus model [4].

GSCM was developed by the Smart City and Community Innovation Center (SCCIC) Bandung Institute of Technology. GSCM is separated into three layers, as shown in Figure 3, with layer 1 representing resources, layer 2 representing enablers, and layer 3 representing services. Smart Management, which includes apps for Human Resources, Asset Management, Procurement, Finance, and Dashboard, is organized into three components. Room access, parking, and payment services are all part of Smart Living. Higher Education's Smart Tridharma in the form of services for teaching, research, and community service. The enablers are the resources required to run the services.

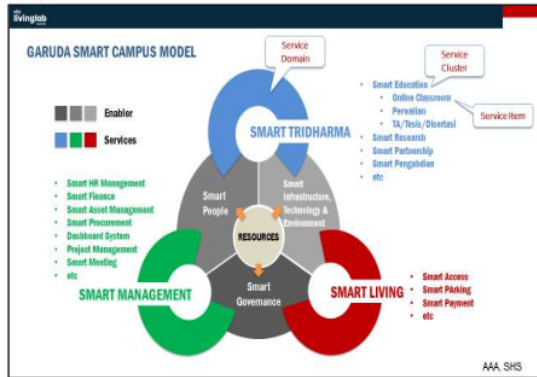


Fig 3 Garuda Smart Campus Model (GSCM)

GSCM has adopted the campus model one of which is the smart tri dharma, which consists of the tri dharma of higher education, namely academics, research, and community service. This is the essence of the campus model.

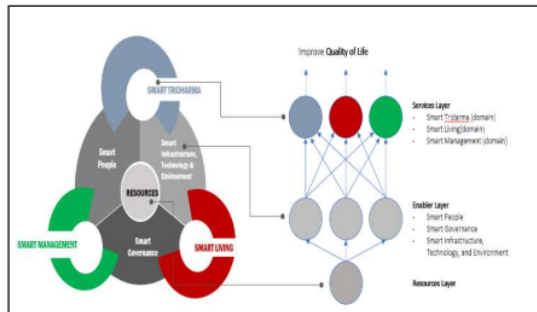


Fig 4 Architectural View GSCM

We agree with the research from Pagliaro [4], but we see that a smart campus model is an integration between the campus model and the smart system model. Therefore, we will use the GSCM model and combine it with the smart system model in the service part of the smart campus.

Figure 5 describes the merging of the Smart System Model with the Garuda Smart Campus model in the services layer where the services to be provided using a smart system so that the process of the Smart System is integrated with the services in GSCM.

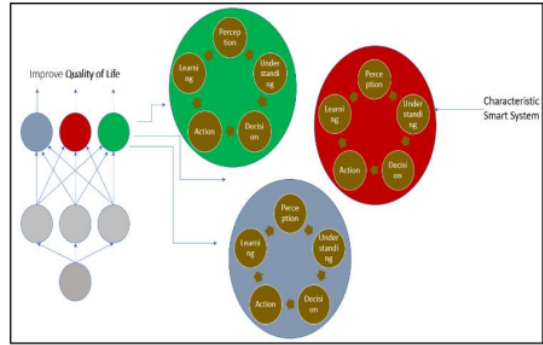


Fig 5 Integration Smart System and GSCM

Excellent service quality will make stakeholders from campus satisfied. The integration of digital technology with the university system will lead to a promise of enabling better performance, cost efficiency, energy efficiency, and other attractive benefits. The smartness of the system will greatly affect the quality of service. Therefore, in every existing service, there must be a smart system that automates the service system.

IV. CONCLUSION

Our research highlighted is to find a smart campus model that is suitable for use in Indonesia. The model used is the Garuda Smart Campus Model which was developed by SCCIC by adding a smart system process to the Smart Campus service so that the level of system smartness can be measured.

V. LIMITATION AND FUTURE WORK

Regardless of the study's findings, our findings should be interpreted considering its limitations. First, because the Smart Campus model has never been used in Smart Campus measurements, it is necessary to implement the model by collecting data from several universities in Indonesia to generate conclusions and inputs on whether the model and indicators can be used. Before we measured the smartness of the smart campus, we need to define the criteria, indicators and implement the model by taking measurements to several universities in Indonesia using criteria and indicators which will be researched further.

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