

# Approaches that Contribute to a New Definition of the “Smart Campus” based on Smart Systems

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# Approaches that Contribute to a New Definition of the “Smart Campus” based on Smart Systems

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**Abstract**— There is a lack of consensus on what constitutes "smart campus," which has led to varying definitions among individuals and organizations. Interestingly, even researchers. To address this issue, this paper aims to examine various viewpoints from multiple researchers to establish a clear definition of a smart campus. The proposed definition of a smart campus will be built on a smart system. Once a definition has been agreed upon, a smart campus model can be constructed around it.

**Keywords**—smart, smart campus, smart system

## I. INTRODUCTION

The word "smart system" is often used in information technology to refer to an intelligent system, which includes smart city systems, smart building systems, and even smart campus systems.[1]. A smart system can be viewed as one that can assist campuses in improving service quality, resolving operational issues, achieving campus vision, and even responding to changes or interruptions. This can be advantageous for colleges that adopt smart systems on campus, sometimes known as smart campuses [2].

The significance of smart systems is consistent with the Industrial Revolution 4.0 period, which has resulted in the adoption of technologies such as IoT, big data, and artificial intelligence in all aspects of human existence [3]. Smart systems also took advantage of cutting-edge information technology during the Industrial Revolution 4.0. These systems collect data, analyze patterns, and respond intelligently using technologies such as the Internet of Things (IoT), artificial intelligence (AI), and data analytics. Smart systems can be found in a variety of settings, including smart homes, cities, factories, and campuses, among others. The purpose of a smart system is to improve overall performance, user experience, and sustainability by seamlessly integrating technology and data[4].

Higher education has an impact on the Industrial Revolution 4.0 period. The education sector that uses smart technologies can promote learning and thinking patterns as well as develop creative and original innovations from students to build the nation's next generation that is superior

and able to compete globally [5]. Implementing a smart campus on campus is a necessity that higher education must change to remain competitive in the industrial era 4.0.

The current challenge for higher education is to improve efficiency in problem solving in the field of education, to increase competitiveness against competitors, and to become appealing to potential students to survive in the face of disruption and intense competition. The approach to accomplishing this is to build a smart system within the campus, sometimes known as a smart campus.

This study defines a smart campus in terms of a smart system. As a result, to understand the definition of a smart campus based on a smart system, it is required to first define a smart system.

A definition is necessary since perspectives about smart campuses differ; hence, a definition acts as a reference and incorporates the elements required by a smart campus. This study contributes to the body of knowledge in the field of smart systems by broadening the perspective on smart systems deployed on campuses, often known as smart campuses, and can be used as a reference for constructing a smart campus. It also contributes to the smart campus study issue, with a focus on smart campus definition using smart systems.

## II. LITERATURE REVIEW

Currently, none of the smart campus definitions that several researchers have studied include smart systems as part of a smart campus. According to Xu Smart campuses are a more advanced form of university informatization that builds on digital campuses by combining emerging information technologies like cloud computing, the Internet of Things, mobile internet, big data, IntelliSense, intelligence business, knowledge management, and social networking.

According to Coccoli [7], a smart campus is a campus that not only adopts current technology and systems but also allows knowledge sharing between employees, teachers, students, and all stakeholders. Smart campuses must

prioritize flexibility, effectiveness, and performance by considering the needs of today's society. The relationship between universities and industry can create an ecosystem that is important for becoming a smart campus.

Tikhonov's research [8] defines a smart campus as the total modernization of all educational activities. In education, the smart concept demands the development of technologies such as smart boards, smart screens, and wireless internet access from anywhere.

According to Nachandiya [9], A smart campus is an element of a smart city where the campus has many sensors and smart terminals using cloud computing technology, IoT, and other technologies. The idea is that administrators, teachers, and students, through intelligent environments, can communicate effectively to improve the learning experience.

Based on Huang [10], A smart campus is an educational institution that utilizes technology which includes information systems, the Internet of Things (IoT), and context-aware computing to improve learning, teaching, and administrative tasks.

According to research from Ahmed et al [11], smart campuses have three main characteristics: personalized services, information services, and technology platforms. They concluded that a smart campus has criteria, namely fast identification of all transactions and a private database that can be accessed via the cloud, improving the quality of learning, being more interactive, more collaborative, time efficient, easy to use, and sustainable, better resource utilization, fewer costs, more sustainability, monitoring and control, more data to analyze, and better planning. Research from Dong [12] explains that with a smart campus, stakeholders can enjoy the comfort of campus life, carry out campus monitoring efficiently, receive early warnings about potential risk events, and have easier institutional management.

### III. RESEARCH RESULT

In defining a smart campus, it is necessary to explain the criteria for creating a smart campus. From these criteria, a definition of a smart campus can be made. In addition, definitions can be made based on definitions that have been made by previously published research. In this research, the definition of a smart campus is related to the implementation of a smart system that has not been studied by previous researchers.

#### A. Smart Definition

Jason [13] defines "smart" as the ability to adapt to changing situations. Romiszowski [14] defines a smart system as one that can turn information input (stimuli) into action (reaction).

The definition of smart in the field of information technology is being connected and able to act semi-automatically based on decisions taken while collaborating and coordinating with other departments.

According to Imbar [2], smart has principles, namely:

1. Sensing is the process of collecting data.  
This procedure is carried out by data collection, which includes both statistical data and direct surveys, as well as data provided by Internet of Things devices, social media platforms, and others.
2. Understanding is the study of existing data.
3. Acting refers to taking action after analyzing the situation.  
Actions may include the creation and/or adaptation of new services, the establishment of policies and regulations, outreach, and training. These activities can be undertaken by either humans, such as through policy, or machines, such as through automation.

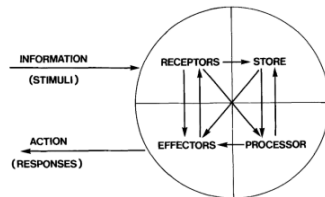


Fig 1. Model Smart [5]

Figure 1 explains about model smart that receptors can perceive relevant events, situations, moods, or problems that can influence the actions taken. Stores can remember facts, concepts, principles, and procedures that have been carried out so that they can further enrich the store. The processor can carry out analysis, synthesis, and evaluation of alternative actions in the process of considering relevant conceptual schemes and restructuring if necessary. Effectors can respond to certain situations.

#### B. System Definition

Based on Von Bertalanffy [15], a system is defined as a collection of interacting elements. If this concept is enlarged, a system is a collection of interrelated pieces that work together as a single unit.

List of concepts that characterize the system [16]:

- Elements: system components,
- Relationship: a relationship between two entities,

- Goal: a set of actions that a system can perform in its environment to achieve its goal,
- Environment: everything that is outside the boundaries of the system,
- Interface: system elements that connect the system and its environment.

C. Smart System Definition

Romero [17] defines a smart system as one that solves problems rationally, exactly like humans, and can reflect on and explain how it solves and defends its conclusions. A smart system can have the following characteristics:

- Communication skills,  
System elements must have the ability to interact to share data, communicate their capabilities, and tell others about the status of their surroundings.
- Embedded knowledge,  
The system must collect human experience and expertise, transforming it into a broad knowledge base in a knowledge-based system that the inference engine may use to make judgments. All system decisions must be knowledge-based.
- Learning capabilities,  
Learning is the process of applying various methods and algorithms to modify knowledge about a system. This skill permits adaptive behavior, allowing for the handling of new contexts or situations. The system learns autonomously and updates its knowledge without the participation of any party.
- Reasoning Capability,  
Smart systems must be capable of making decisions based on their knowledge. Reasoning also enables the system to anticipate future environmental conditions and respond accordingly.
- Perception Capability,  
Smart systems are continually perceiving and comprehending their environment and themselves. This would not be possible without sensors that can detect and track changes in their environment. Smart systems can define and analyze the environment using data collected by sensors.
- Control Capability,  
Actuators provide control capabilities by executing system decisions with available resources.

According to Supangkat[18], a process is said to be smart if it receives input through sensing, processes it into knowledge through understanding, and then takes action through acting. The results of these actions improve the initial sensing process so that the system becomes smarter.

Based on Romiszowski [14], Romero [17], and Supangkat [18], a smart system must have criteria, namely being able to solve problems, being able to sense, being able to understand, and being able to make decisions. (actions), and these actions can be improved by the learning process. From these criteria, the definition of a smart system is a system

that can respond to stimuli by applying knowledge so that it can solve important but difficult problems. Knowledge is obtained through the learning process. Smart systems have a cycle consisting of sensing, understanding, decision, action, and learning [19].

The definition of a smart system in this research is a system that can respond to stimuli by applying knowledge so that it can solve important but difficult problems.

D. Smart System Model

A smart system is a system that can respond to stimuli by applying knowledge so that it can solve important but difficult problems. Knowledge is obtained through the learning process. Smart systems have a cycle consisting of sensing, understanding, decision, action, and learning.

From the characteristics of smart systems, several researchers, such as Romero [17], Jason [13], Romiszowski [14], and Alter [20] can specifically determine the requirements of the smart system model, as can be seen in Table I.

TABLE I. REQUIREMENT FROM SMART SYSTEM MODEL.

Smart System Model	
Requirement	<ul style="list-style-type: none"> <li>• Capable of detecting, understanding, decision-making, action, and learning</li> <li>• In the form of a cycle/loop so it can be smarter</li> </ul>
Impact	Offer smart solutions for users.
Input	Data, stimuli
Output	Information, Action, Response

Figure 2 explains the characteristics of a smart system based on the level of automation consisting of sensing, understanding, decision, action, and learning. A smart system must be able to carry out a learning process so that the system can become smarter. The learning process forms a cycle depicted in Figure 2. The smart system cycle was designed referring to research from Romiszowski [14].



Fig 2. Model Smart System

Table II. contains definitions of each smart system cycle.

TABLE II. DEFINITION SMART SYSTEM CYCLE

Component	Definition
<b>Sensing</b>	Ability to receive both relevant data and information.
<b>Understanding</b>	Ability to transform knowledge into alternative actions for subsequent steps.
<b>Decision</b>	The ability to choose the optimal answer from among multiple choices depending on a variety of factors.
<b>Action</b>	The ability to execute produces results.
<b>Learning</b>	The system's ability to improve its cognitive skills is based on experience with information handling.

A smart system model receives data from current forms or sensors. This process is known as sensing. Following the sensing process, the understanding process will resume. This process converts knowledge into alternative actions for the next stage. Next, we move on to the decision-making and acting stages. At this point, we will select the best option from a list of alternatives based on a variety of criteria and proceed to achieve the desired impact.

#### E. Smart Campus Definition

In this study, the notion of a smart campus refers to the installation of a smart system that has not been explored by other researchers, as described in the literature review.

Overall, various pieces of literature demonstrate that while discussing a smart campus, the emphasis is on upgrading the education system through the employment of smart concepts and digital technology as crucial aspects in issue solutions.

From the literature review, it can be concluded that the smart campus criteria are:

1. use of information technology in campus management.
2. can improve the quality of service for all stakeholders where stakeholders obtain benefits or solutions from the existence of a smart campus.
3. can smartly solve campus problems.
4. can achieve the university's vision by providing services that can be personalized according to the needs of each stakeholder.

From the smart campus criteria that have been described and the definition of a smart system, a definition of a smart campus can be made as a campus that implements a smart system in carrying out its mission to achieve its vision.

#### IV. CONCLUSION

Based on the prerequisites for a smart campus, we may conclude that a campus is smart if it can utilize its knowledge to study, resolve stakeholder conflicts of interest, and use public intelligence to increase the system's cognitive ability. Smart campuses, like smart cities, offer smart services to their residents to improve their quality of life by using intelligent systems. A smart campus concept must be applied before a regular campus can be considered smart. The smart campus model will be produced by the definition of smart campus defined in this research, and it will be developed in the following study.

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