Smart Campus Framework: A Solution for New Normal Education System

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***Abstract*— The Covid-19 pandemic has affected all aspects of human life and has even forced humans to shift their life habits, including in the world of education. The learning model must shift from the traditional to modern synchronous or asynchronous models with information technology-based applications. This condition is known as the New Normal era in the education system. Y Generation and Z Generation as educational objects are now very close to technology, especially information technology, including in the teaching and learning process, so there is no need for extra effort in this regard. Therefore, it is essential to create a learning environment under the characteristics of this generation and can also support the new normal era of the education system. We offer the concept of a smart campus framework that integrates an IT-based learning system and a hybrid smart classroom system as a modern education method in an educational scenario that promises to accelerate quality education without leaving a good learning process. This article designs the concept of a smart campus framework that will accommodate a learning model that will accelerate the improvement of the quality of education through smart learning solutions and smart blended learning systems. We also offer achievements in improving service performance through smart academic services solutions and accommodating the management of existing classroom resources through smart equipment system solutions. This framework is designed to automatically solve all university-level education system problems based on multimedia and integrated with websites and information systems used on campus.**

Keywords— smart campus; Z generation; hybrid classroom; COVID-19 Pandemic; New Normal Education

I. INTRODUCTION

The COVID-19 pandemic's New Normal conditions affect the pattern of human life in the health sector and education. The Covid-19 pandemic has shifted the learning system's habits from face-to-face methods in the classroom to virtual face-to-face both synchronously and asynchronously. To slow the spread of this disease, direct interaction between students and teachers and between students and other students must be reduced while maintaining the quality of the existing learning system.

In today's increasingly competitive environment, high-quality education is essential. Different approaches to Gen Y and Gen Z as educational objects today must be considered due to fundamental differences in characteristics with the previous generation. Because of the growth of modernity in education, the traditional approach to learning systems with lecture and note-taking models has been seen as losing effectiveness. To advance academically, efforts must be made to create a system to support an increasingly modern learning process. The system must be able to solve a variety of problems that frequently arise during the learning process.

Based on the initial conditions, it is deemed necessary to have an integrated solution between the classroom environment and learning applications that allows direct connections between students, teachers, and administrative staff as an integral part of the education system while not violating the rules or the new normal concept. The connection between these three components of education should be possible anywhere and at any time, without regard for space or time constraints and without jeopardizing the quality of education itself. The interaction between the classroom environment and learning applications performed by students, teachers, and education staff can be realized by utilizing advances in information technology and is referred to by several terms such as smart campus, smart university, or smart classroom.

The system is implemented using the PHP framework Laravel programming language with support for JQuery, javascript, and MYSQL databases and other supporting software both web-based, Internet of Things, and standalone programming such as visual basic.

The research was done concerning providing smart and efficient classroom services and accommodating online and offline learning models. It necessitates the use of integrated learning systems, classroom control, and administrative services. This research aims to create a smart campus framework controlled by digital and computerized electronic systems that are integrated with educational information systems and learning management systems. The findings of this study are expected to result in a smart campus system that can be used by any educational institution based on its infrastructure and services. With the implementation of this smart campus framework, students, lecturers, and the entire academic community will obtain some of the services they require in a more effective, efficient, and appealing manner.

If the research results from the development of the Smart campus framework can be implemented as technological

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innovations, they have very promising prospects. Educational and other institutions will be greatly aided in improving the quality of learning and the effectiveness and efficiency of service quality for students and the entire academic community. With its smart learning system, smart academic services, smart blended learning, and smart equipment, it ensures that this smart campus innovation will be the first choice among the many existing smart classroom models, so we believe the results of this research are auspicious to be developed as a technology applied to the world of education.

II. SMART CAMPUS CONCEPT

The term Smart Campus is derived from the English phrase "Smart Campus." The smart phrase here is the available information technology on the campus in question. In terms of the Smart Campus concept, it is a campus that implements and integrates learning systems through information technology. So, the goal of Smart Campus is to make teaching and learning more efficient by leveraging information technology [1].

The use of information technology through the Smart Campus system facilitates the teaching and learning process and benefits campus management affairs, libraries, etc. The Smart Campus system includes features such as an integrated academic information system, a learning management system, CAT Online, e-Office, E-Library, student evaluation of lecturers, and a study tracer system.

The Smart Campus concept can be described in detail, in which all elements related to campus become interconnected with one another through the use of Smart Campus. Everything is linked, beginning with lecturers, employees, students, parents/guardians, and operators facilitating campus activities [2].

The use of the Integrated Academic System is one example of Smart Campus implementation. Employees can use student lecture data for other system purposes using the Integrated Academic System on Smart Campus. On-campus, the correspondence system is packaged using an electronic office (E-Office) [3]. Numerous other applications can help implement smart campuses, such as those in the financial system (finance), libraries, smart cafes, smart parking, scholarships, and other areas of interest.

Furthermore, some see smart campuses in terms of equipment capabilities and smart classrooms. The classroom's equipment is linked to the Internet via the Internet of Things (IoT) devices, which can be controlled remotely via applications. Remote systems, for example, can turn on room lights, AC, and LCD from other locations; attendance systems use various sensors; and room security systems use biometric authentication such as fingerprint, face recognition, or smart card authentication. This smart campus model is more commonly called the smart classroom [4]–[7].

The features of the smart classroom concept continue to evolve and change in tandem with the advancement of technology. Today's smart campus concept is the ability to carry out a blended learning system that combines online learning from home and offline learning in the classroom, both carried out concurrently [8]–[12].

Based on the foregoing explanations, it is possible to conclude that some of the features or capabilities of a smart campus system include:

- Integrated Campus Information System, which includes academic information systems, e-offices, and new student admission systems, among other things.
- A learning management system that is integrated.
- A classroom automation system based on IoT.
- A system of blended learning.

III. PREVIOUS WORK

Several previous studies on the smart campus concept have been conducted. These studies are also very diverse and focus on various topics, including smart classrooms, smart learning, smart environments, and so on. Abuarqoub et al. [13] conducted a study titled "A Survey on Internet of Things Enabled Smart Campus Applications" that focuses on how to present the smart campus concept using Internet of Things (IoT) technology. It is almost identical to Chang Ching Hisan's [14] research on Smart Classroom, titled "Smart Classroom Roll Caller System with IOT Architecture," which focuses on student attendance systems using an RFID Card, which then matches the number of students present in class with the number of RFID cards installed in the slot provided. The disadvantage of this attendance method is that students can still cheat by asking their friends to take their class. We will use a biometric system in the student attendance system as a solution.

Another similar study, "A Smart Classroom Application: Monitoring and Reporting Attendance Automatically Using Smart Devices," was conducted by Gokhan Sengul et al., [15], in which attendance was controlled using a Bluetooth signal from each student's smartphone. Each student registers their smartphone's MAC address, which is then matched during lectures. This method cannot be implemented in Indonesia, particularly at various universities, because not all students have Bluetooth-enabled smart devices.

To keep costs low, methods for developing a distribution model for local content, linking local content to digital signage, and distributing it has been researched. The study employs a "one-source, multi-purpose" approach, automatically retrieving local content into a database, registering it in a digital signage database, and displaying it. Based on this research, researchers designed and developed a prototype used in field trials of digital signage for tram transportation [16]. With the title "Smart Card-Based Smart Classroom System and C++ Programming Language," Gintoro et al. [17] investigated the Smart Classroom, which focuses on controlling equipment in the classroom. They focused on lecturer attendance only using smart cards in this study.

Meanwhile, the lecturer is still manually recording student attendance. Employees control room equipment remotely, such as turning on lights, LCD projectors, and unlocking classroom doors. As a result, it takes employees who continue to maintain and remotely control class devices under the class schedule, resulting in decreased effectiveness.

There have been many previous studies in the realm of smart classrooms. From 2012 to 2018, there have been studies conducted from various domains, with the majority of them researching how to build intelligent classrooms that are

controlled automatically. Some conduct research in the areas of E-Learning, cloud learning, Learning Management System (LMS), Virtual Learning Environment (VLE), collaborative classroom model educational approaches, and many others who focus on other topics as part of the use of technology in education [5]–[9], [12], [15], [18]–[20]. In our case, we want to create a smart classroom system that focuses on ubiquitous learning systems and context-aware learning for millennial students.

The first state of the art is how to create the concept of a smart learning environment for Gen-Z students, which includes ubiquitous learning and context-aware learning. Here, gen-Z students will be able to access subject matter quickly and easily, and applications will be created to support various learning models for gen-Z, such as collaborative learning, project-based learning, flipped learning, and others. This section presents an e-office application that integrates the learning management system (LMS), thesis management system (TMS), and academic services information system.

The second state of the art is how to present a smart environment that integrates smart blended learning and smart equipment solutions that are automatically controlled by the smart classroom application, making it easier to carry out all learning activities, such as synchronous offline and online learning, smart attendance, classroom controller, and classroom security.

IV. NEW NORMAL EDUCATION SYSTEM

A. Smart Campus Education System

In this article, we present the "Smart Campus Framework," which consists of four (four) integrated learning system solutions based on information technology (1) Learning system solutions provided by a smart learning system comprised of a Learning management system and a thesis management system. (2) Face-to-face learning solutions are limited to a "smart blended learning system" that allows learning to take place both offline and online synchronously. (3) Academic service solutions via "smart academic services," including e-mail and e-office systems. In addition, (4) A classroom control solution is provided by a "smart Equipment solution," where users can control classrooms remotely. The architectural design of the smart campus framework system that we provide is shown in Figure 1.

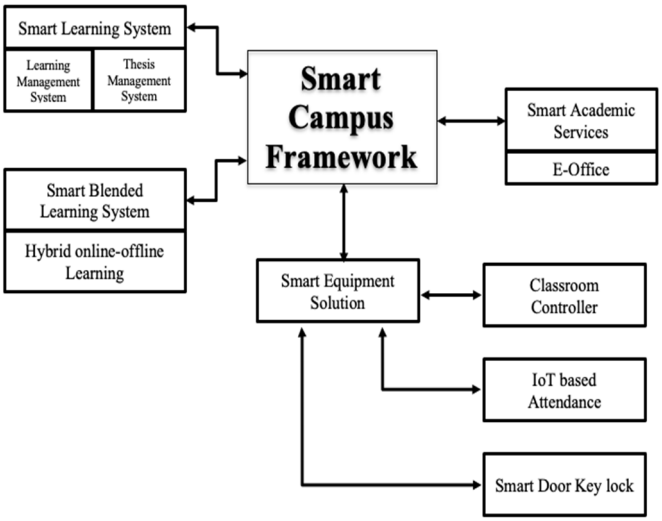

Fig 1. Smart Campus Framework Architecture

B. Hardware Design

- Smart Blended Learning System

This Smart Blended Learning System is a learning concept that supports synchronous and asynchronous learning systems. This concept is based on limited face-to-face learning, which allows students to attend the class for a maximum of 50% of the time. The synchronous blended learning solution exists to avoid lecturers or teachers providing repeated material in the same class.

The concept of synchronous blended learning that is being implemented is in the form of implementing online learning technology that seeks to present an environment similar to offline learning in the classroom. The solution proposed is to use multiple cameras that run concurrently to monitor learning activities from various angles. In this study, the primary focus of synchronous blended learning is on camera surveillance tasks that include three camera sources: teacher view, whiteboard view, student (classroom) view, and one presentation source (teaching materials). The four supporting sources operate synchronously (simultaneously), with the camera monitoring lecturers' teaching activities, student learning activities, and displaying the whiteboard view.

Because there are so many sources that must be displayed at once in online learning activities, it can be difficult for a teacher or lecturer to focus on the video conference display. Manually changing viewpoints can also be time-consuming, making learning less efficient. As a result, a video conference controller application was created, along with intelligent tracking zoom on the movement of teachers or lecturers, so that the learning environment can be more lively and similar to an offline environment. The network topology used in this synchronous blended learning system is depicted in Figure 2.

According to the image, three cameras are linked to the system via local Wi-Fi and the Internet for video conference application requirements during online learning. This smart blended learning application's function is to configure the camera activated in the video conference application or share learning materials. This application is designed to work with various video conferencing platforms such as Zoom, Google Meet, Microsoft Team, etc. Figure 3 depicts a flowchart of how to use this intelligent blended learning application.

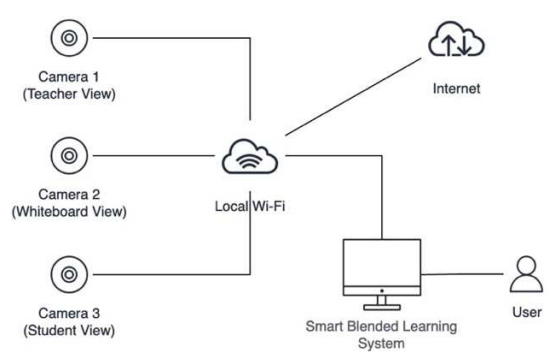

Fig 2. Network Topology Smart Blended Learning System

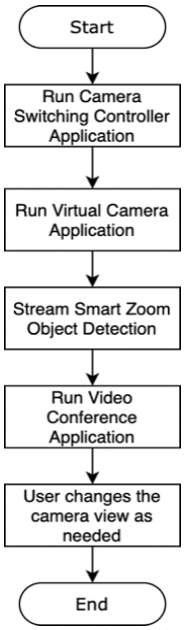

Fig 3. Flowchart of using blended learning system application

The flowchart depicts the flow of application usage, beginning with the execution of a desktop-based controller application. The virtual camera can be launched from the controller application and used to detect stream smart zoom objects. When the camera is ready, the video source from the virtual camera application can be used in the video-conferencing application. At this point, video conferencing will be formed for online learning systems. At the same time, students in the classroom are also ready to learn offline by using various classroom facilities such as projectors, whiteboards, or listening to direct explanations from lecturers. This application allows lecturers to control the camera and video conference display easily. The lecturer's view camera is activated if the lecturer wants students to go online and see the lecturer explaining in class; if the lecturer will explain by writing on the whiteboard, the whiteboard view camera is activated. Furthermore, the application can display teaching materials in the form of presentation slides and student perspectives in class.

- Smart Equipment Solution

The Smart Equipment Solution concept refers to controlling classroom equipment such as lights, air conditioning, LCD projectors, classroom security systems, and attendance systems. The concept of smart equipment is based on Internet of Things (IoT) devices that can be controlled via an integrated information system.

The offline attendance system, which uses biometric face recognition and body temperature sensors, is linked to the Learning Management System (LMS) application, which records student attendance at each meeting. Meanwhile, an online attendance system is being developed in the LMS application for online students.

The light control system, air conditioning, LCD projector, and classroom keys can be controlled remotely or set based on time by the appropriate class officer.

C. *Software Design*

- Learning Management System

In this case, the learning application, or E-Learning, makes use of an E-Learning application that is already in use on campus. This application can be used in conjunction with other applications that support the smart campus system. We use Syam-Ok, the LMS of Universitas Negeri Makassar (https://syam-ok.unm.ac.id) for its implementation on campus. This LMS is built on the Moodle application, integrated with the campus academic information system, so that class creation and user management are automatically synchronized.

- Thesis Management System

The difference between the traditional learning process and the final project mentoring process necessitates developing this Thesis Management System (TMS). Because of this distinction, the final task guidance process is not covered by LMS Syam-Ok. As a result, we created a final project guidance information system application (thesis, thesis, and dissertation), which we named TMS and put online at https://tms.fbs.unm.ac.id. This application aims to make it easier for students, lecturers, and staff to collaborate on final project guidance. This TMS application covers the entire exam process, from submitting a final project proposal to closing the exam and providing the final score. The scope of the TMS application is depicted in Figure 4 as a use case diagram.

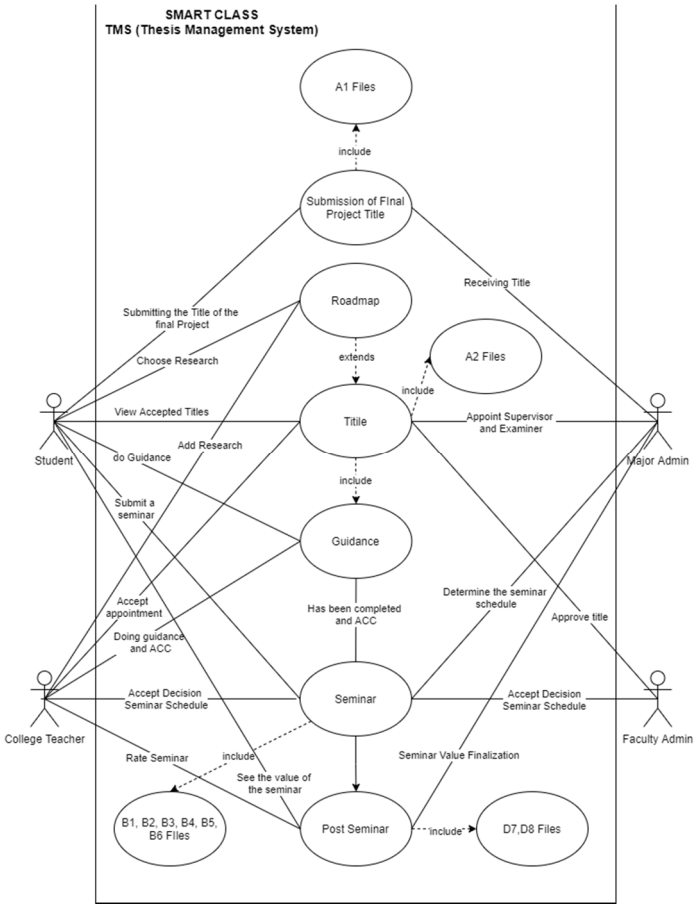

Fig 4. Use Case diagram of Thesis Management System

According to the use case diagram, there are four actors in this TMS application: students, lecturers, department administrators, and faculty administrators. Students will submit a final project title, select a research title based on the lecturer's research roadmap, provide guidance, submit a proposal seminar schedule, seminar results, and final exams, as well as see their scores. According to their responsibilities, lecturers can write down their research roadmap for students to follow, provide guidance and approval, and evaluate test results as a supervisor or examiner. Meanwhile, the department administrator is responsible for accepting or rejecting student research titles, selecting supervisors and student final project examiners, and determining the seminar schedule. The faculty administrator's role here is merely that of a verifier to approve student's final assignments and student final exam schedules. Students and lecturers can only obtain the supervisor's and examiner's decision letter, as well as the exam schedule if the faculty admin has given permission.

- E-Office

To explain the system design used in realizing the research on the university's correspondence administration e-office system, it is necessary to first understand the general business flow processes, particularly the existing correspondence administration system, as shown in Figure 5.

According to the diagram, three main actors are involved in the correspondence administration system at the university level: administrators or operators, leadership groups and lecturers, staff, and students. Meanwhile, the managed correspondence administration system includes receiving incoming letters, outgoing letters, registering outgoing letters to regulate numbering, and a system for directing incoming letters to appropriate units or individuals.

Furthermore, in Figure 6, we present the system design results in DFD (Data Flow Diagram). This DFD is a system design tool oriented to data flow with the concept of decomposition that can describe the analysis and design of systems in a way that system professionals can easily communicate to users and program makers.

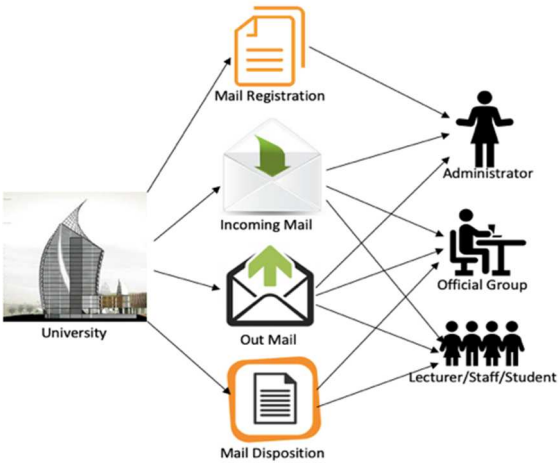

Fig 5. Business Process Flow in University

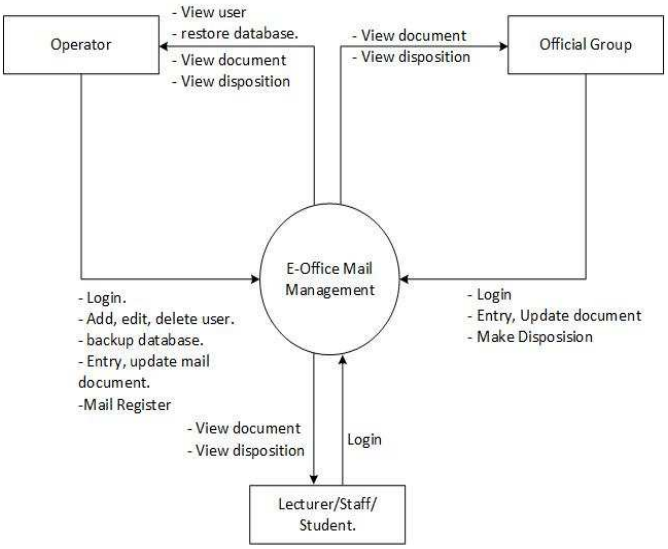

Fig 6. College E-Office System Context Diagram

According to the context diagram, this application has three user entities: administrators, staff, and faculty/college leaders. Each entity has different rights and privileges based on its needs. This application is also available on the domain https://surat.fbs.unm.ac.id.

D. Learning Scenarios

The first scenario involves the use of a "smart learning system," which entails the use of a learning management system (LMS) and a thesis management system (TMS). The LMS application is used as an online learning medium by both lecturers and students. Lecturers upload their teaching materials and manage various learning activities on the LMS application, while students access teaching materials and perform activities requested by lecturers. Using a web service, data and learning outcomes in the LMS application will be retrieved and sent from/to the academic information system (API). Meanwhile, students, lecturers, and administrators from majors and special faculties use the TMS application for final project guidance activities, beginning with submitting the title of the final project and ending with the closed exam. Using a web service, the data and results of this TMS are also retrieved and sent from/to the university's academic information system (API).

The second scenario involves using "smart blended learning," in which classrooms are set up and configured to support both synchronous online and offline blended learning. Each class has three cameras and a PC with blended learning and video conferencing software installed. All cameras are linked to a PC via Wi-Fi and the Internet for video conferencing and learning. When a lecturer offers synchronous blended learning, they can customize the display that students who take online learning will see in four different modes: the view of the lecturer who is teaching, the whiteboard view, the classroom view, or the presentation slide view (projector). These four perspectives will provide students with a genuine learning environment.

The third scenario involves the use of "smart academic services" applications such as e-office. This application can meet all of the academic service needs of students, lecturers, and staff.

These three scenarios have been implemented and tested successfully at the university level. The Smart Campus service provided is extremely beneficial to the higher education community in promoting a more effective and efficient learning model. Indeed, smart learning systems, smart blended learning, and e-office can improve universities' quality of learning and services. They are straightforward to customize by retrieving information from the university's academic information system based on the conditions and needs of each institution.

In the smart campus framework that we provide, lecturers, students, and staff have access to all systems in the smart campus through a single login that is the same as the login used for college academic information systems. The display design is straightforward, user-friendly, and simple for anyone to use, and this solution integrates with all existing systems in universities via web service communication (API). In this framework, another scenario in a "smart equipment solution" will be developed. Users can access the implementation of this smart campus framework via the https://smartlearning.fbs.unm.ac.id domain.

V. CONCLUSION AND FUTURE WORK

We designed four learning system solutions and service systems at the university level in this framework: smart learning systems, smart blended learning, smart academic services, and smart equipment solutions. These four solutions have made interaction between students, lecturers, and university staff easier, which will result in more effective and efficient learning and services.

So far, we have successfully implemented and piloted three solutions in real classrooms or environments: smart learning systems, smart blended learning, and smart academic services. Our next major task will be to implement a “smart equipment solution” scenario.

Currently, the design and implementation of our smart campus framework are still ongoing, emphasizing issues that continue to emerge and must be resolved to produce a smart campus framework in a global formulation.

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