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A COMPARATIVE ANALYSIS OF DEVELOPMENT POLICIES FOR SMART UNIVERSITIES IN VIETNAM

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Abstract. *In recent years, the concept of smart universities has been introduced as a part of the broader initiative of developing smart cities that are based on the principles of science, technology, and engineering. As the construction and development of e-government and smart cities continue to progress, the transformation of universities into smart universities is becoming increasingly inevitable. This study conducted an analysis of the development policies in the latest related studies in Vietnam and around the world to clarify the main contents of the smart university model and to facilitate the transition of Vietnamese universities. Field experiment was conducted and its analytical results confirmed the efficiency of the proposed smart university model named SMSU.*
Keywords: E-government, Smart university, Digital transformation, Comparative research, Education policy analysis

1. **Introduction.** The advent of the Industrial Revolution 4.0 has brought forth numerous challenges [1-3], and created novel occupations in the labor market [4-6]. This transformation necessitates that education provides learners with the ability to adapt to these challenges [7-10] and new requirements that traditional educational methods cannot meet [9,11,12]. Therefore, universities, as the primary source of high-level human resources for society [6,7,9,13], must comprehensively change their models [12,14-16], program contents [10,12,13,17] and training methods [18-21].

The Vietnamese Government has set a vision for 2035 through the formulation of a Higher Education Master Development Strategy for the 2021-2030 period, with a vision to 2035[1], as a basis for innovation, comprehensive, and sustainable development in the long-term of its higher education system.

Numerous conferences have been held to discuss the impact of Industry 4.0 on Vietnamese education, and many educational institutions have actively embraced new waves of educational technology to conduct training processes. However, the concrete actions and strategies for the process of educational industrialization have been slow to materialize. The digital transformation of universities is still in its nascent stages. Advanced

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[1]https://baochinhphu.vn/xay-dung-chien-luoc-tong-the-phat-trien-giao-duc-dh-viet-nam-102236641.htm

university management and governance models, as well as new training methods, information technology, and science and technology at a high level, have been piloted in some universities in Vietnam.

The urgent requirement for higher education today is to have a smart university model that is suitable for the reality of Vietnamese universities to orient the process of educational technology in Vietnamese universities. Therefore, this study applies the innovative systematic analysis method [22] to determining the necessary components, thereby proposing a suitable smart university model and a reasonable conversion method. This will create conditions for the application of information technology, information systems in management and administration, as well as support to change training methods and training programs in Vietnamese universities. The contributions of this study are twofold: (i) A framework for smart universities named SMSU is proposed; and (ii) an intensive survey and a field experiment are conducted to confirm the feasibility and efficiency of SMSU.

The rest of this paper is organized as follows. Section 2 reviews the recently related work of the research domain of smart universities worldwide. Section 3 introduces the SMSU framework and elaborates its components and transformation methods. Section 4 presents the survey results of educational experts and a field experiment of applying AI-support module following SMSU architecture. Section 5 concludes the contributions and figures out future work.

2. **Related Work.** The transformation from traditional education to smart education is inevitable to meet the new requirements of the Industrial Revolution 4.0 [9,12]. The research and implementation of smart university models are taking place very strongly worldwide, along with the trend of digital transformation of management and administration units as well as cities [16,22-24]. Conferences related to this issue have been held to help experts and researchers exchange and discuss more deeply. One of the first conferences in this field was The World Learning Summit (WLS) and the Learning Innovation and Quality (LINQ) 2017 with the topic "*Smart Universities: Education's Digital Future*" [25] which gathered articles related to training trends in the digital environment. This conference mentioned the concept of smart university as well as factors related to smart university. However, studies only focus on the primitive factors in smart university: online teaching, using media in teaching 1, open university, not to mention the overall view of smart university.

Uskov is one of the pioneers in building the smart university model [26]. He drew a panoramic view of the components as well as the technical and technological aspects. Accordingly, smart university and smart education represent the integration of the following: (i) intelligence and intelligent systems [26,27], intelligent objects [28,29] and intelligent environment [16]; (ii) intelligent technology [28,30], various branches of computer science and computer engineering [6]; (iii) modern intelligent educational software, hardware systems [23,26,31], agents, tools [31-34]; and (iv) innovative pedagogy [19,35], teaching strategies [13,20], and advanced technology-based learning methods [31,32,36].

Mbombo and Cavus [37] commented that smart university is a university that uses technological innovation within its organization to accomplish its mission. This research focuses on the concept of a smart university that incorporates within it the concept of big data and elearning, while showing its impact on teachers, learners and the educational institute in general.

Pérez et al. [24] proposed to address these issues by using a university campus as a less complex mock-up version of a city. They proposed an IT conceptual framework to model and implement smart university projects, which supports the design of a platform that

is both in line with the strategic plans of universities and is flexible, sustainable, stable, and sufficiently modular to support the addition of different value-added services over the years. Their framework was based on a service provision model materialized in an IT architecture and managed following a methodology to integrate IT components that ensure the insertion of new, smart initiatives of value to the community, aligned with the university's needs, via a value-added service planning process.

Villegas-Ch et al. [16] pointed out the trend of applying the technologies and techniques of the smart city model to universities based on the architecture of big data. This trend aims to improve the comfort of people in areas such as security, mobility, and energy consumption. The authors proposed an IT conceptual framework to model and implement smart university projects, which supports the design of a platform that is both in line with the strategic plans of universities and is flexible, sustainable, stable, and sufficiently modular to support the addition of different value-added services over the years.

In addition to the trend of studying the smart university model of researchers, managers, as well as software companies, have also come up with initiatives and solutions in the field of smart education and smart universities in recent years. For instance, Smart Education Inventor (SEI)[2] in Korea focuses on new pedagogy, new learning environment and interaction between teachers and learners.

BM has created the IBM Smarter Educational Framework [38] (now cloud-based and known as IBM Cloud for Education) to demonstrate how it works in partnership with customers to support and enable smarter educational institutions, making them more efficient, productive, and competitive. Smarter education drives sustainable performance improvement by leveraging information to make better decisions, anticipate problems and resolve them proactively, and coordinating resources to operate effectively.

Samsung's Smart School solution[3] has three core components: (i) the interaction management solution, (ii) the learning management system, and (iii) the student information system. Its many unique features and functions are targeted at smart school impact on education and benefits, including increased interactivity, personalized learning, effective classroom management, and better student monitoring.

In Vietnam, the study on the smart university model as well as the transformation from traditional university to smart university is still very limited because of the novelty of the topic. Most of the studies in Vietnam focus on teaching and training online, e-learning, and more recently, blended teaching and learning. On January 25, 2017, the Government of Vietnam approved the Project "Strengthening the application of information technology in management and support for teaching and learning activities, and scientific research, contributing to improving the quality of education and training period 2016-2020, with a vision to 2025" with the goal of forming an educational database. The project aims to achieve targets; for example, 100% of state management agencies and educational and training institutions will implement manage and process work records in the network environment; 70% of professional training classes for teachers and education administrators are conducted in a combined method (face-to-face and online). There have also been pilot projects to deploy the smart school model, but only at lower levels of education. For higher education, the new training program allows learners to learn online up to 30% of the program's content.

Lê and Lê [39] have given orientations and proposed solutions on increasing the application of the smart university model to universities in Vietnam in the context of the booming Industry 4.0. This study focused on the direction of open university based on

[2]https://www.springerprofessional.de/birth-and-major-strategies-of-smart-education-initiative-in-sout/12317916

[3]http://csr.samsung.com/en/programViewSs.do

Massive Open Online Courses (MOOCs) with a smart university model that is the combination of three factors: Internet of Things (IoT), intelligent support tools (including hardware and software), and human factors. However, the combination of these factors is not clear.

Some studies as well as software suppliers have also introduced smart university models but only at the conceptual level, thereby conducting evaluations based on these models. Nguyen et al. [40] have measured the performance of information systems applied in universities according to the model of V-SMARTH, including 6 basic components: digital resources, open access learning materials, virtual learning environments, personalized education, interactive learning and digital platforms. This study also approached the concept of smart and ready level of smart university.

Thus, studies only focus on one or a few elements in smart universities: online teaching, using smart media in teaching-learning, open university, integrating intelligent systems into management, administration, and support for teaching and learning activities; manage campuses with advanced, intelligent technology and techniques. Research does not mention an overall model of smart universities or its components and they have not yet proposed a conversion process or applied a general artificial intelligence model, despite it being a large and complex model that relates to various aspects of university education. Only Uskov et al.'s research [26] provides an overview of the smart university model. However, the model lacks coherence and connection between fields and objects, as well as information on how the systems in the model are deployed. This study demonstrates the components of the smart university model, the connection between these components, the process of transforming and deploying from traditional universities to the proposed smart university model.

3. The Synthesis Model of Smart University.

Section 2 has identified the crucial factors and components that constitute a smart university. However, their perspective is limited to specific aspects of a smart university and does not encompass all the necessary areas. This study proposes an overall model of a smart university that covers the following areas: smart university, smart education, smart learning environment, smart campus, smart teacher, and smart classroom. The model is developed by applying an innovative systematic approach and analysis [22] in conjunction with the policies of the Government of Vietnam. The Synthesis Model for Smart Universities (SMSU) is illustrated in Figure 1.

The functionalities of the main components of SMSU are summarized as follows.

- **Smart University (SmU)**: A comprehensive modernization of all management processes, education, research, commerce, and other activities of the university based on information technology, leading to complete new results and quality.
- **Smart Learning Environment (SLE)**: Technology-enabled learning environments that make adaptations and provide appropriate support in the right place at the right time based on individual learner's needs, which can be identified via analysis of learning behavior, performance, and the online and real-world contexts.
- **Smart Education (SmE)**: A smart, student-centered, multidisciplinary education system that links schools, university institutions, and workforce training, powered by smart technologies, using smart tools and smart devices.
- **Smart Campus (SmC)**: Encompasses at least, but is not limited to, the following aspects: comprehensive online learning, social networking and media for work collaboration, green and sustainable ICT with intelligent sensor management systems, preventive and protective healthcare, smart building management with automated security monitoring and controlling, and visible campus governance and reporting.

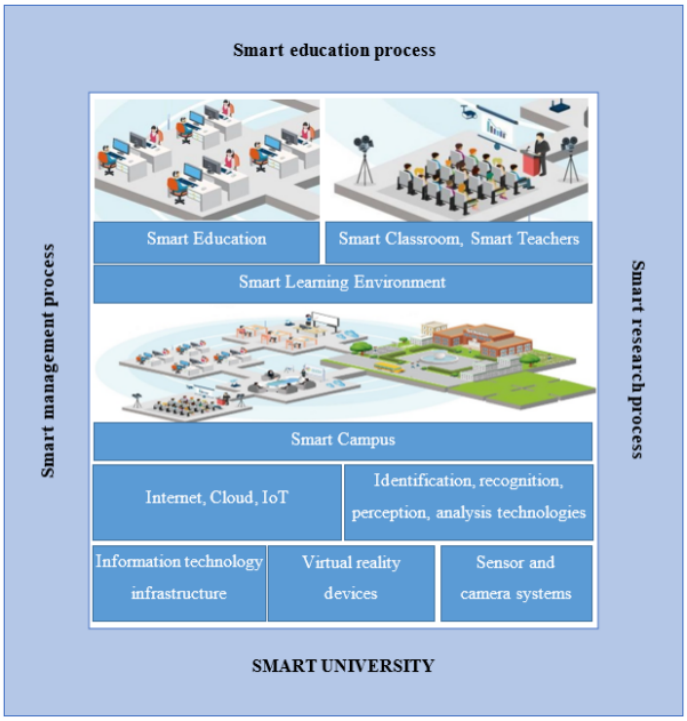

FIGURE 1. SMSU model

- **Smart Teachers**: The overall strategy involving people, facilities, and ongoing support teachers use technology effectively, providing them with intelligent tools and ongoing support to carry out their work while also assessing their pedagogical effectiveness with intelligent assessment forms.
- **Smart Classroom**: A smart classroom involves optimized presentation of teaching content, convenient access to learning resources, deep interactivity of teaching and learning, contextual awareness and detection, classroom layout and management based on smart technologies. Smart classrooms integrate speech recognition, computer vision, and other technologies, collectively known as intelligent agents, to provide a tele-education experience.

To establish a connection between the aforementioned fields, the model will utilize advanced technologies based on the foundation of the Internet, Internet of Things (IoT), Cloud, virtual reality, sensors, recognition, and identification technology. In conjunction with these technologies, software systems that support learning, teaching, recording, video recording, identification, recognition, monitoring, analysis, and analytic, forecasting, and inference tools will be employed. These tools provide real-time assessments and reports, support teaching and learning, and facilitate management and administration activities.

Transformation method of traditional university to smart university. The method of transforming the traditional university model into a smart university has been proposed by [26] and improved by [41]. Within the scope of this study, we combine both above methods with the author's comments, assessments and adjustments based on Vietnam's higher education development policies to determine the necessary transformation factors as well as the appropriate transformation process.

Previous studies on the transformation and development of smart universities have primarily focused on the human factor, specifically the teaching staff, which is the main productive force of universities [19,20]. After the experiment, changes in thinking and the spirit of accepting change were observed in the majority of lecturers, which led to

changes at the university administration levels. These studies mainly focused on teaching and learning, research, as well as supporting tools for these activities [15,42].

A crucial factor in the construction and development of smart universities, particularly in smart cities and e-government, that has rarely been mentioned in previous studies is the administration factor and the change related to it [43,44]. If we consider the entire transformation process as an IT project, one of the key issues that often takes place in the early stages is the transformation of the governance model, where the project determination and support of leaders, especially senior leaders, will decide the success of the project [45].

To complete the transformation to the smart university model, universities need to comprehensively change three aspects: governance model, program content, and training methods. This is based on our knowledge of the transformation and IT application in organizations.

1) Transforming university governance model

Given that smart universities are the modernization of management, education, research, commerce processes, and other activities, it is appropriate to focus on transforming the governance model first. People with an innovative mindset, new proposals, experimental, and changed acceptability will be at the forefront of the transformation. Universities need to transform their university management model by applying advanced management models that have been successfully implemented in businesses such as ERP systems. Implementing ERP systems in universities helps standardize management processes based on the application of information systems that support management and operation of fields within the university, as well as technical infrastructure and technology that are deployed as a platform to connect sub-systems [24,46,47].

After transitioning to a new management model, universities can leverage the existing information technology and communication infrastructure to construct smart classrooms, the central element of a smart university, which receives significant attention from various stakeholders as it determines the success of the smart university. The development of the smart university model primarily relies on the most fundamental component, the smart classroom, but at a higher level with the integration of multiple technologies and equipment on a larger scale. Numerous tools, sensors, and supporting technologies are deployed in the smart classroom.

For smart classrooms, universities can opt to deploy synchronized infrastructure, techniques, hardware, and software (gesture recognition, action recognition, context awareness, speech-to-text and text-to-speech synthesis, analysis, virtual reality, monitoring), technologies (IoT, Cloud, RFID, WNS, and other intelligent technologies), or selectively deploy each component according to their specific needs [31,48,49].

After implementing ERP systems and constructing intelligent classrooms, universities can proactively expand the transformation to other areas such as smart campuses, intelligent learning environments, smart education, and intelligent teachers, thereby gradually perfecting the smart university model as proposed above [48,50,51].

As universities transition to the smart university model, they gradually achieve smart levels at each stage. Specifically, the transformation takes place at each level of smart university (Figure 2).

For each level, there are specific instructions, implementation objects, achieved output quality, as well as risk and disadvantage reduction. The highest "intelligent" level of smart university is Level 5 – Optimal level, where all professional faculties and administration apparatus of smart university have the ability to continuously evaluate and optimize their operations. Smart university at this level also achieves the highest output quality. In

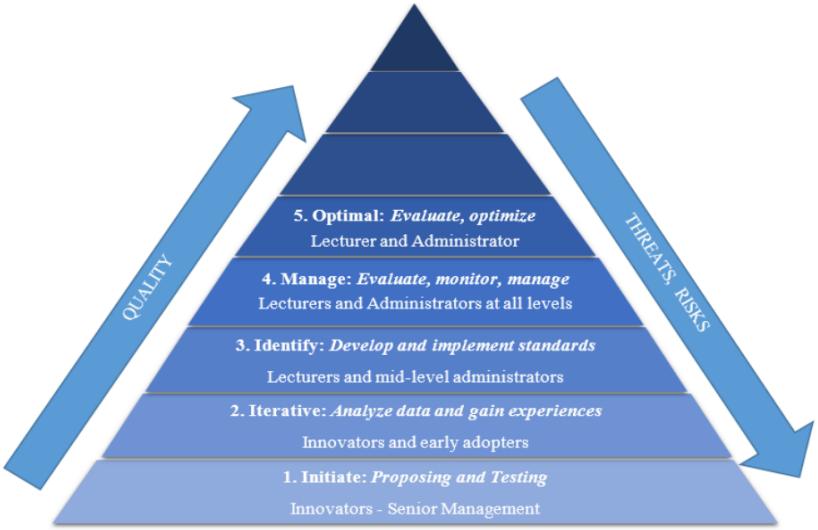

FIGURE 2. Transformation method according to SMSU

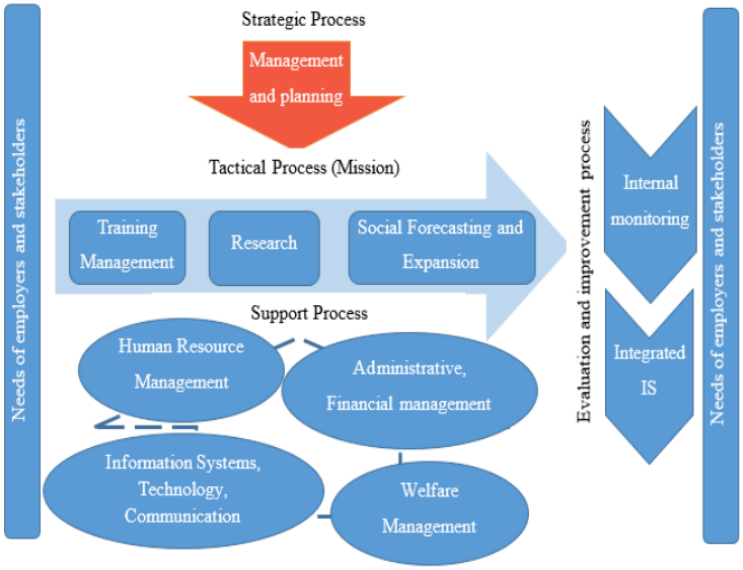

FIGURE 3. Management processes in the university

contrast, at Level 1 – Initiate level, innovators only make proposals and test the smart university model.

Besides the proposed SMSU and its transformation process, this study presents a comprehensive process for the deployment of smart universities, which includes both tactical and strategic processes. This overall process is illustrated in Figure 3. Along with the formation of support processes, administration and operations systems serve the main task in the university, training, and research. Additionally, there are always evaluation and improvement processes based on internal monitoring activities on the basis of integrated information systems.

After the implementation of supporting processes and the planning and management of resources based on integrated information systems such as ERP, universities will have a solid foundation to proceed with other digital transformation activities. This includes the improvement and renewal of training program content and training methods. The objects of the university, such as lecturers and learners, will also accompany the advances

of science and technology by using hardware and software products to support teaching and learning activities. This creates a premise to adapt to new training methods.

2) Transforming training program content

To meet the needs of society and stakeholders (Figure 3), universities must make corresponding changes, primarily in terms of training content. Universities have made adjustments in program content, must ensure other indispensable skills, such as the ability to think systematically, synthesize, link the real and virtual worlds, creativity, teamwork skills, and interdisciplinary cooperation.

After transforming the university governance model, universities will be better equipped to adapt to changes in science, engineering, and technology. This will enable them to develop training programs that meet the requirements of society and provide quality human resources for the labor market.

3) Transforming training methods

To convey content suitable for today's smart society, the smart university model needs to apply real-virtual systems (Cyber Physical System – CPS) and IoT. CPS systems are typical features of the Industrial Revolution 4.0 environment, which are the basis for designing and building smart factory models. CPS is usually designed with 5C structure (Connection, Conversion, Cyber, Cognition, Configuration).

With the availability of IT, information system and communication infrastructure in the transformation of the management model, the connection and integration of new systems for new training methods will also be easy. Those who directly participate in the new training method are lecturers and learners who have prepared and familiarized themselves with previously deployed support systems, reducing adaptation time, increasing efficiency and education quality.

4. **Experiment.**

In this study, we implemented both interview analysis and case-study experiment to evaluate SMSU framework. The former targeted at analyzing experts' opinions about SMSU framework, while the latter demonstrated the feasibility of AI component in SMSU architecture.

4.1. **SMSU – System evaluation.**

In order to evaluate the feasibility of the proposed SMSU framework, we implemented an interview with 60 experts who are leaders, managers, lecturers in universities. These experts were divided into 4 teams belonging to 2 groups: managers and lecturers. Specifically, there were 6 Board of Directors, 10 department heads, 14 faculty managers, and 30 lecturers in the field of IT and management information systems.

The interview results showed that 100% of experts confirmed the need of technology application and the conversion to a smart university model at universities. However, there was difference between manager group and the rest about the implementation time of smart university. To be more specific, the majority of managers (70%) wanted immediate change in transformation activities, while the rest need further time for consideration. For the areas of the SMSU including smart management processes and smart governance more than 85% of experts confirmed the need for transformation.

Specifically, the experts' most interested areas were smart learning environment, smart education, smart classroom with more than 92% choices for the need of SMSU. For more details, the technology integration, software and management information systems which support the training and examination processes, were the most important tasks of universities.

4.2. **Evaluating AI-integrated module.**

Since SMSU proposed a new framework for smart university which covered the transformation process from traditional university to

smart university, in this sub-section we chose an AI-integrated module of SMSU architecture which assist language lecturer in assessing students' written essays.

To be more specific, this AI-integrated module, which is composed of deep learning model, recognizes handwritten text in scanned essays and transfers them to Word document format. Then, these documents play as inputs for the error detecting process including checking grammar, vocabulary and plagiarism. The final results are presented to lecturers for assigning final marks. In order to evaluate the efficiency of this AI-integrated module in assisting teaching process, a field experiment was conducted in 2 months with 2 classes of English writing course. The 70 enrolled students were randomly assigned to these classes which has 35 students per class. One of these classes was applied traditional teaching method, while the other was assisted by AI-integrated module. A short survey was conducted after the courses finished. Both lecturers and students were invited to join the survey and the results are shown in Table 1.

Table 1. Survey result

Question (5-scale Likert question)	**Traditional class**		**AI-assisted class**	
	Lecturer	**Students**	**Lecturer**	**Students**
Q1: Did you satisfy with learning results? Completely dissatisfied – Dissatisfied – Neutral idea – Satisfied – Completely satisfied		2-1-4-17-11		3-0-2-16-14
Q2: Were you tired with the grading process? Very tired – Tired – Neutral idea – Not tired – Completely not tired	0-1-0-0-0		0-0-0-1-0	
Q3: Were you stressed by the students' essays? Very stressed – Stressed – Neutral idea – Not stressed – Completely not stressed	0-1-0-0-0		0-0-0-1-0	
Q4: Did you satisfy with the teacher's suggestion? Completely dissatisfied – Dissatisfied – Neutral idea – Satisfied – Completely satisfied		5-5-3-10-12		0-0-1-12-22
Q5: Do you agree to use AI-assisted tool in teaching process? Completely disagree – Disagree – Neutral idea – Agree – Completely agree	0-0-0-1-0		0-0-0-0-1	

As the survey data showed, there was no difference between the two student groups about the satisfaction of their learning results. However, there were 10 out of 35 students of the traditional class, which reached 28.5%, dissatisfied with their teacher's suggestion on their written essays. This number of the AI-assisted classes was counted 0. This result implied that students of the second group had more satisfaction of their received suggestion than those of the first group. Another implication was the efficiency of AI-assisted module in supporting lecturer to deliver his/her suggestion for students. In another view, the lecturer of the traditional class expressed his/her negative responses to the questions numbers 2 & 3, while positive responses were made by the lecturer of the second group.

These results implied that AI-assisted module efficiently supported the lecturer during his/her teaching process. The need of AI-assisted module was confirmed by both of the two lecturers in their responses to the question number 5. In general, this experiment result indicated the need and efficiency of smart module of SMSU.

5. **Conclusion.** This study presents the SMSU framework encompassing critical components such as intelligent university management, advanced campus infrastructure, adaptable learning environments, innovative educational methodologies, interactive classrooms, and skilled pedagogical teams. To operationalize the SMSU, the study outlines a phased transition process for media universities migrating towards a smart university paradigm. This transformation prioritizes three key areas: 1) administrative modernization, 2) curriculum reshaping, and 3) instructional redesign. Survey and field experiment were conducted and the analysis of experimental results confirmed the feasibility of SMSU approach. Subsequent research endeavors will delve into the granular details of the conversion process, culminating in the development of efficacious implementation strategies for establishing a fully functional smart university.

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