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Research for building the smart university model at Thu Dau Mot University

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ABSTRACT

In recent years, society has been evolving rapidly, and contemporary education is being adapted to satisfy people's requirements in accordance with 4.0 trends and the industrial revolution. This gives birth to the definition of Smart University, the study of which seeks to identify the required components for constructing a smart learning environment. The research group analysed nationally and internationally advanced models, proposing a smart university model for Thu Dau Mot University (T-SMARTHS) with smart levels matching the phases established and developed at Thu Dau Mot University.

Keywords: *Smart university, T-SMARTHS, TDMU*

1. Research situation overview

The smart university (SmU) is an advanced process that will create opportunities and conditions for a university to enhance its adaptive capacity and develop a balance to the rapid changes of society in general. Specifically, learners are able to discover and create knowledge, develop mastery and adaptive capacities, and think creatively through personalised pedagogical instruction, tailored to their unique points and individualised needs; increase the significance, reliability, usefulness, flexibility of the curriculum content. In Vietnam, online teaching has been quickly deployed to provide a source of knowledge for students promptly and simultaneously as a temporary measure to cope with Covid-19. Online learning on platforms such as Team, Zoom, and Google Meet is suitable under the circumstances that learners (pupils, students) cannot attend school in person, contributing to the continuation of teaching and learning activities. Online

teaching is implemented through applications suitable for each learner, and schools are also organised to train instructors (teachers, lecturers) on how to use software to achieve optimal results in the online teaching process. However, in recent years, online teaching at some schools has not yet attracted the attention and interest of learners, thus, has not yet achieved high efficiency like traditional teaching in classroom. In traditional education, lecturers give theoretical and practical lectures directly, and students are less likely to apply their knowledge to solving any problem. When transferring to a SmU, students must actively study and collaborate better in groups to increase their knowledge. In addition, lecturers can train students with many skills while applying new teaching methods along with modern equipment, creating an inquisitive, stimulating learning environment. Inspired by the existing literature, the research group has drawn lessons for the development of smart universities in Vietnam in the future in general and at Thu Dau Mot University in particular.

2. Theoretical basis

Smart university definition

In Italy, the smart university project of the University of Trento stated that the smart university is a diverse platform – providing personalised services to students in inner Italy universities and universities around the world. The first deciding factor is WeNet, the Internet of Us ("Our Projects – Smart University", 2022). Besides, the research group (Tikhomirov et al., 2015) introduced that smart university is a concept related to the comprehensive modernisation of all traditional educational processes and innovative education to deliver a new university, in which the core of development in information technology. The faculty will lead a new quality of education, research, processes and outcomes, commerce and other university activities. Research group (Vladimir et al., 2017) proposed a smart university definition that a smart university is a place where knowledge is shared seamlessly and is a strong, green system, personalised, responsible, interactive and adaptive, and accessible anywhere, anytime, and from any types of devices.

In Vietnam, the authors (Hung et al., 2022) shared that the concept of a smart university has many approaches. From the perspective of what the school is doing and is researching, the concept of a smart university is generalised as a higher education institution oriented to digital transformation and using digital infrastructure, digital human resources, digital data, and digital technology to provide personalised learning services to learners of all generations, meeting the requirements of lifelong learning and sustainable development. It is a basic idea for making a SmU. Smartness simply is innovative solutions to solve problems and challenges the university poses during its operation for the sustainable development of that university. One note is that in a smart university, technology is a tool to help solve problems; not applying technology is already smart. Innovative solutions to university challenges are called smart. From the above conceptual points of view, the

research group has concluded that: "Smart University is an innovation-oriented university developed from smart technologies to provide personalised learning services to learners of all generations, meet the needs of lifelong learning and sustainable development of individuals and society".

The levels of the smart university

The group (Vladimir et al., 2017) (Serdyukova et al., 2016), (Uskov et al., 2016) and (Colleen et al., 2018) have identified 5 characteristics considered as the five intelligence levels of SmU and arranged them in ascending order.

– **Adaptive Level:** SmU can automatically modify business functions, teaching/learning strategies, administrative, safety, physical, behavioural and other characteristics, etc., to operate and perform better their primary functions to suit the environment.

– **Sensing level:** SmU can automatically use various perceivers to sense, identify, and understand events, processes, objects, phenomena, and impact (positively or negatively) on the operation, infrastructure or condition of SmU, and its students, faculties, staffs, resources, assets.

– **Level of Inference:** SmU can automatically draw logical conclusions based on raw data, processed information, observations, evidence, assumptions, rules, and logical reasoning.

– **Self-Learning Level:** SmU can automatically acquire, collect or form new or modify existing knowledge, experience or behaviour to improve its operation, function, to increase the efficiency and effectiveness of the system.

– **Predictive Level:** SmU can automatically predict and reason what event will happen, how to deal with that event and future actions.

– **Level of Self-Organisation and Restructuring:** SmU can change its internal structure (at component level), self-regenerate automatically, and purposefully self-sustain (in a non-random manner) under the right conditions without having external actors/entities. Noted that self-protection, self-connection, and self-repair are part of the self-organisation.

To assess the smart levels of a SmU in Vietnam, (Nguyen Huu Duc et al., 2020) proposed that a smart university include 5 levels:

– **Level 1 – Information acquisition and connection (Connection):** School systems can collect information and connect stakeholders to solve issues related to the learning environment and teaching methods, learning objects, and teachers' teaching styles. These systems can be customised to adapt to devices such as computers, tablets, phones or operating systems such as iOS and Android.

– **Level 2 – Conversion of information and digitisation:** From the information collected and managed at level 1, systems in level 2 can connect them and bring them together for

statistical results. For example, the results of the statistical studies can be the student's level of attendance, students' learning results, the lecturer's number of lecture hours, and classroom and laboratory use situations.

– **Level 3 – Analysis and Diagnostics (Cyber):** From the results of Level 2 analysis, Level 3 systems can analyse, make diagnoses, and learn from the results to refine the system. For example, the system can analyse student results and faculty quality after collecting data on students' learning activities.

– **Level 4 – Identification and prediction (Cognition):** The system at level 4 will use the results at level 3 to forecast possible outcomes and provide corresponding solutions. In particular, the system can forecast learning outcomes, student performance, predicting the quality of teaching by faculty (student participation, student understanding), or the Campus-wide Safety System to predict, recognise and act appropriately on school grounds.

– **Level 5 – Configuration:** SmU can self-modify internal structure, optimise and self-sustain purposefully. For example, the system automatically identifies systems, parameters, sensors, and features in a smart classroom that are appropriate for the subject, class characteristics, and instructor; the system automatically identifies the system, hardware, software, and features in a smart classroom, self-healing systems in the event of a failure like auto-locking servers.

Smart University Model

Model in the world

Alicante University's research group has researched and built a smart wifi control panel. The **Smart WIFI section** (Alicante, 2022) , of the SmartUA control signpost allows monitoring and observation from the heat map and analysis of the current status of the university's or Smart City's WIFI network, which is quickly materialised in time or defined periods in addition to representing obtained data or mean values, and skim through them. The data generated by the Alicante University EDUROAM wireless network is stored in a NoSQL database, allowing for the fast and efficient processing of millions of data, giving greater improvement to performance, reliability and agility. These data can be analysed through heat maps or control signage analysis tools.



Figure 1. Smart WIFI control panel

Heat map

The heat map of wifi in some areas around the Smart City allows us to observe and indicate the concentration of wifi connections at any point in the campus or of the city from the heat, which defines the hierarchy of the two poles, using warm colours to show regions with more connectivity, while cool colours representing regions with a lower number of devices. With these data, it will be possible to analyse areas of greater concentration of users or devices to warn the system that it may fail due to saturation or high traffic, check the effectiveness of access points, generate alarms from historical data or a defined threshold, and even combine data with power consumption indicators to optimise energy sources.

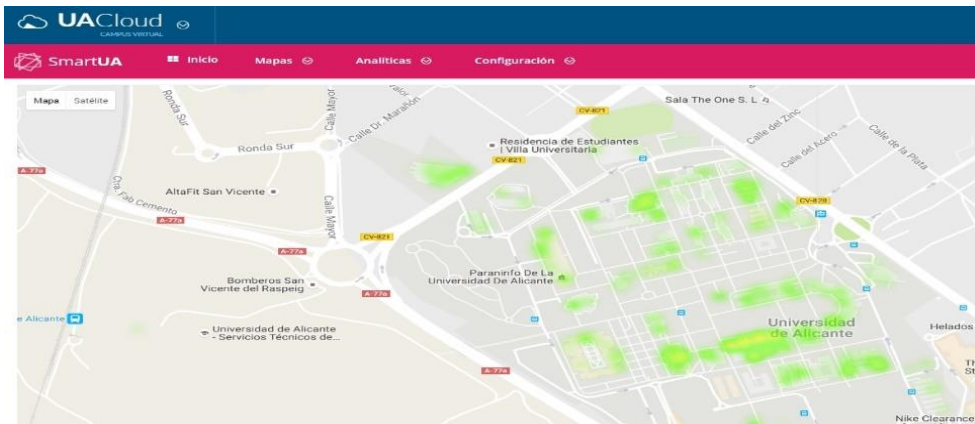


Figure Error! No text of specified style in document.2. Smart WIFI heat map

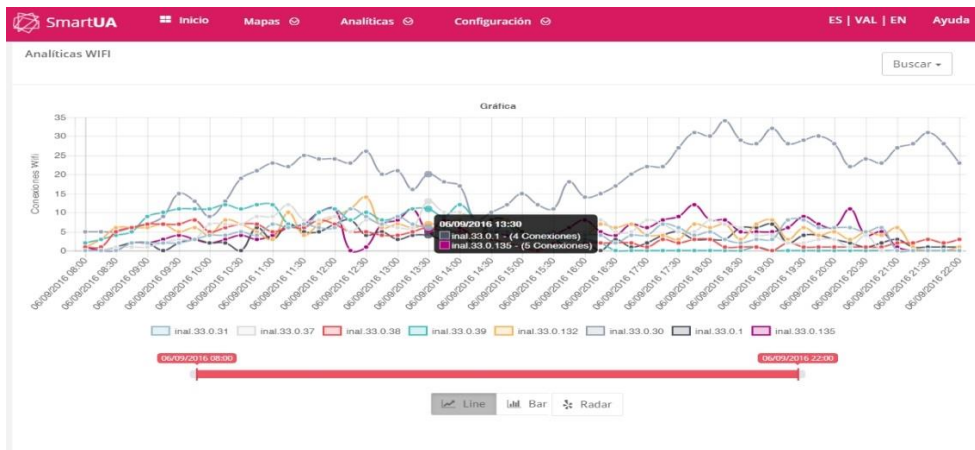


Figure 3. Smart WIFI data analysis chart

According to (Uskov et al., 2017), Bradley University (USA) has been actively participating in the research and development of conceptual models, strategies, smart learning environments, smart classrooms and systems, intelligent software and hardware to move from the traditional university model to a well-thought-out and well-discussed SmU model. Bradley University scientists published remarkable results on the SEEL scientific conference series, showing the pioneering role of Bradley University in SmU and smart education.

Model in Vietnam

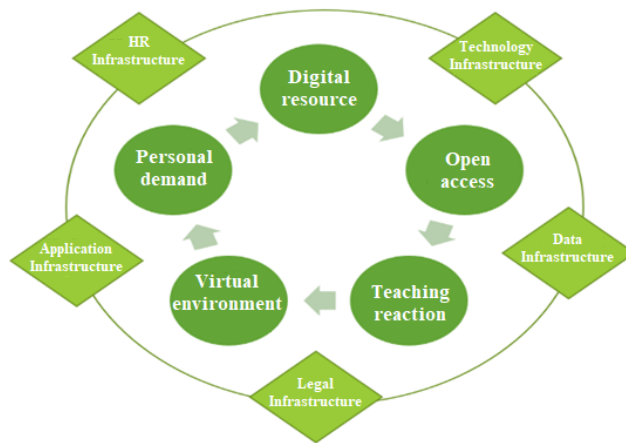


Figure 4. Model V-SMARTH (Nguyen Huu Duc et al.,2020)

Currently, researchers in Vietnam have been involved in building SmU models, such as (Nguyen Huu Duc et al.,2020). When researching the implementation of the smart university in Vietnam, they have proposed the essential elements of a SmU (V-SMARTH model) including: Digital Resources (S); Open Educational Content (M); Virtual Educational Environment (A); Unique learning needs (R); Interactive educational environment (T); Digital infrastructure (H).

3. Proposed model of Smart University at Thu Dau Mot University

Thu Dau Mot University is one of the places to train and provide quality human resources for the province and the whole Southeast region. At the same time, the school is transforming and changing the teaching model from the traditional university environment to the Smart University environment based on the theoretical research models in the world and in Vietnam, on the basis of the University's characteristics, Binh Duong University is in the process of self-reliance as well as through the method of researching the opinions of experts, the research team proposes a smart university model at Thu Dau Mot University with 7 elements:

Smart campus: At the smart campus, individuals have an ideal learning environment. At the T-social smart campus, learners can use all kinds of devices to access the school space system through T-Learning cloud education system, which support students and lecturers to acquire digital knowledge. T-management will manage physical aspects such as smart building, access and security control, monitoring and response to emergencies. T-green cyber system will be optimised to become an ideal and sustainable green space. T-campus will provide an approach that comprehensively connects the above systems. Smart technology can also notify university officials about students struggling with their grades or not coming to class regularly.

Smart people: In an intelligent educational environment, the students will be educated in all aspects. The students will gain the ability to adapt well with flexible systems on campus on any external environments. In addition, in a smart learning environment, students' soft skills, i.e., capabilities to listen and self-control, will be trained, which is highly beneficial for their future careers.



Figure 5. The role of cloud computing



Figure 6. T-Campus platform for pillars

Smart research: In the learning process, laboratories and smart spaces will help students unleash their curiosity and creativity. The T-research system will help students research anytime, anywhere, and the research space will make it easy for students to study and motivate students to have a passion for research.

Smart management: Smart governance is one of the essential elements of a SmU. The management system will administer the university 24/24 with the advice of the University Council in order to build a suitable and intelligent learning environment to meet the needs of society.

Smart technology: It can be said that smart technology is a critical factor in establishing a SmU. The state-of-the-art technologies such as Ai, IoT, and Blockchain can be applied to facilitate building of infrastructure for the smart university system.

Smart influence: Smart influence is one of the strategies to develop Thu Dau Mot University into a political, economic and cultural center in the Southeast region. The primary goal is to build the university into one of the top universities in Vietnam and become a role model in innovation for domestic and foreign universities.

Smart training: The training program structure will be administered flexibly in each period to equip learners with skills closer to the market's demands. Students can keep track of their learning progress and study more effectively. Smart training programs will be implemented so students will actively participate and control their own studies.

Based on the research results at home and abroad, as well as on the above mentioned factors, the research team proposes the smart university model T-SMARTHS.

- Digital Resources (S): Internally generated digital resources, "diversified" digital textbooks; faculty and students jointly develop academic resources and conduct innovative research. Externally produced digital resources from external publishers and libraries. Access and administrative rights for internal and external users. Externally produced data used for resource development.
- Open access study curriculum (M): Open learning materials and information. MOOC online lectures. Open training program. Cross-platform connectivity. Link usage with other universities
- Virtual Education Environment (A): Online training: integrated online training classes, elective classes, reinforcement classes, enrollment classes, and homeworks. Models of reality - virtual, mixed reality, reality - photo. Monitoring, checking and evaluating online: monitoring, testing, and evaluating learning process. Internally produced virtual models which are highly customized for different lecturers. Students can freely create virtual learning materials.
- Individual learning needs (R): Teaching-learning according to the defined program (face-to-face and online); teaching on mobile devices. Teaching-learning according to individual's capability, orientation, interests, and needs. Random teaching- learning, according to micro-nano certifications. Lifelong learning. Learning every time and everywhere. Learning on cross-platform devices
- Interactive educational space (T): Subject activities and interactive features are digitised, teaching-studying has interaction and cooperation between lecturers and students, learner interaction and digital learning materials, interaction, exchange in studying groups, creative research space
- Digital infrastructure (H): Digital legal infrastructure, human resources infrastructure, digital data infrastructure, digital technology infrastructure, digital application infrastructure, and digital governance infrastructure.

- Digital training (S): The training framework changes with business trends, highly effective changes of learning programs, the number of training programs, building an attractive program framework, build a Digital Transformation Center to create a digital workforce to meet the needs of digital transformation



Figure 7. Model T-SMARTHS

From the above research results, the research team proposes stages at Thu Dau Mot University to develop into a Smart University.

Phase 1 - Financial autonomy: Thu Dau Mot University is transitioning to financial autonomy starting in 2022, and it is one of the critical steps to transition to a SmU. The university will be financially independent, facilitating the rapid and effective deployment of projects.

Phase 2 – Getting Started: The school will prepare the school's infrastructure, intelligent systems, and high-quality resources, at the same time, foster high-level professional skills for the school's permanent lecturers. In phase 2, the Smart University Development Board will be formed, where the executive team with a strategic vision will discuss the development direction of infrastructure, smart university systems, and databases.

Phase 3 – Testing: In phase 3, testing of the system on a small scale from classrooms is conducted and expanded to the entire campus. At this stage, the Smart University Development Board will report the results of the test implementation of the system to the University Council. The remaining drawbacks and issues can then be discussed and resolved to develop a comprehensive system. The University Council will evaluate the report's results and will decide to deploy the entire system to turn the university into Thu Dau Mot Smart University.

Phase 4 – Operational Deployment: After being approved in phase 3, the smart systems will be synchronously deployed into the school's system. Students and lecturers will learn in a smart environment. At this stage, the system will develop and optimise, automatically giving solutions for the upcoming issues arising during the operation of the system.

Phase 5 – Comprehensive: In phase 5, it will be the stage of announcing Thu Dau Mot University to become a comprehensive Smart University in all aspects, bringing the university to a higher development in the region.

In each of the above stages, we need to recognize and evaluate each stage to serve as a basis for improving, building and achieving good results; the research team proposes smart university degrees including 6 levels.



Figure 8. *Smart university development levels at Thu Dau Mot University*

Level 1: Transformation: Educational institutions prepare infrastructure, data systems, test infrastructures and intelligent data systems from classroom scale to the entire campus system school. The lecturers and students have to experience the newly implemented learning environment and teaching methods. At this stage, it is necessary to deploy equipment and technology to monitor the situation and made constructive changes to the teaching and learning activities, creating a premise for development at Level 2.

Level 2: Receiving Information: The infrastructure and intelligent data systems in the university are deployed synchronously, collecting information fields, connecting stakeholders, and automatically correcting the change of functions such as student learning environment, teaching methods, learning objects, teaching styles of lecturers, learning time. These systems can be customised to adapt to different devices like computers, tablets, phones or different operating systems like iOS and Android.

Level 3: Information Processing - Digitisation: From the information and data collected and managed at level 2, systems are built and developed in level 3 with the capability of connecting them and giving specific logical and statistical results for each

object. The system will collect processing information and then digitise the information. For example, to assess the degree of student's diligence, student's learning results, we can collect and assess the number of teaching hours of the lecturers, the student's evaluation of the lecturer, the level of student registration by each lecturer, the situation of using classrooms, laboratories, and function rooms.

Level 4: Analyzation - Digitization: a system in this level 4 can analyse, make diagnoses, and learn from those results to draw experiences from the current behaviours to improve operations, professional functions, efficiency and effectiveness. For example, after collecting data on student learning outcomes, the system can analyse why students do not achieve good results, such as studying too many subjects in a semester or missing too many lessons.

Level 5: Identification – Prediction: The system at level 5 will use the results from level 4 to predict possible outcomes and provide solutions. For example, there is the ability to predict student learning outcomes, forecast faculty teaching quality, and enrollment management systems to predict and control changes in annual student numbers.

Level 6: Optimization: Smart University can self-modify the internal structure, optimise and self-sustain the system operation in an intentional (non-random) way under appropriate conditions without any external impact from any individual or entity. For example, the system automatically determines whether the system, parameters, sensors, and features in a smart classroom are appropriate for the subject and the lectures, the characteristics of the class, adjusts the lighting condition. The system automatically redefines the system, hardware, software, and features in a smart classroom tailored to each lecturer.

4. Conclusion and recommendations

4.1. Conclusion

The research on Smart University has theoretical and practical implications in line with the trend of modern education to improve the capacity to adapt to the development of modern technology, thereby improving the quality of education at universities to contribute to the development of smart universities in Vietnam in the future. With the methods of researching documents, consulting experts, the author has provided the rationale for the smart university model in the world to then propose the smart university model at Thu Dau Mot University through the development stages. The transition from the General University to Digital University is a thorough preparation, synchronous implementation, and investment in infrastructure, management staff, teaching staff, and the social environment in Binh Duong province. This process has advantages because Thu Dau Mot University is always aware of the importance of digital transformation and pioneers, proving that the University has established the Digital Transformation Scheme and established a Forecasting Center to contribute to the success of the process of building a Smart University. However, there are still many difficulties and challenges in the

process of investing in facilities to meet the needs, qualifications, and capacity. There is still a need for solutions to improve the quality of human resources for training.

4.2. Request

According to the research team with the current strategic vision, universities should gradually transform themselves into smart universities to meet the needs of modern educational development. The model of the research team built according to the research at Thu Dau Mot University for successful implementation needs to have a synchronous implementation between investment in facilities, learning environment, competence level of the management team, teaching team, and students' experience. Therefore, it is necessary to build a smart university in stages and evaluate the implementation process through the levels proposed in the study.

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