

Enhancing Smart Universities with Emotional Intelligence

Competences for Digital Age Learning

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Chapter 1

Introduction to Smart Universities Issue

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Introduction to Smart Universities Issue

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1.1 Introduction

Many different types of “smart” items have grown more integrated into our everyday lives in recent years. Examples include smart houses with sensors for lighting and heating, smart meters for energy, and smartphones that combine these functions with smart watches for other uses. These days, smart cities are becoming more and more common, which are spreading over the globe in reaction to two contemporary phenomena: the rapid increase in the world’s urban population and the digital revolution. Campuses of universities share many amenities with small cities, such as multipurpose buildings, shops, sports and medical facilities, transportation networks, security systems, and waste and energy generation/distribution systems, and as a result, they face comparable difficulties. Universities have been transforming reality via critical thought and education for many centuries. The digital revolution, sustainability, and societal change have all benefited greatly from university involvement (Belousova, Belousov & Narkevich 2021; Karadağ & Boğan 2022). Smart education is replacing conventional education, and technology is a vital tool in this process. Industry 4.0, technical breakthroughs, and socio-economic challenges are driving this transformation (Elsakova, Kuzmina & Kochkina 2019; Tikhonova 2019). Universities are moving toward becoming smart campuses, or toward the process of smartization. The goal of the

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university smartening process is to modify the existing structure in order to develop the idea of an open university. In order to achieve sustainability and a high standard of living, it seeks to modify the management model, infrastructure, and community interactions (Rico-Bautista et al. 2020). Digital technology has shown significant promise for the education sector, with several applications designed to enhance instruction at all levels, from kindergarten to tertiary education. We utilize all of the smart applications available to us to manage our security cameras, heating systems, lighting, and other networked devices (Albino, Berardi & Dangelico 2015; Hilty & Aebischer 2015; Min-Allah et al. 2019; Min-Allah & Alrashed 2020; Morze, Smyrnova-Trybulska & Glazunova 2021). Internet of Things (IoT)-based solutions, according to authors (Ahmed et al. 2018), are the cornerstone of every intelligent infrastructure. These clever solutions improve people's quality of life, lessen environmental stress, foster creativity, and foster a strong sense of community by efficiently mobilizing and using the required resources. Smartphones and the IoT have revolutionized the market, leading to the creation of a growing number of solutions that aim to improve customer comfort. Every university has changed its vision in response to the progress of education and other fields, which are often properly connected to international education reforms. The educational landscape is being progressively transformed by technological advancements, including e-learning and IoT, which are radically altering the manner in which educators deliver instruction and instruct students (Rosak-Szyrocka 2024a). Universities have also recently begun presenting "smart campus" initiatives and making data about their campuses and operations available to the public wherever feasible. The University of Cambridge and Southampton University in 2024 provide the public complete access to energy statistics for every facility on campus. One of the many features of the smart campus platform Glasgow University intends to provide is "a place to gather and display open data about the Campus". Higher standards and innovative approaches to learning and teaching strategies—smart pedagogy—as well as unique, technologically advanced services for local, on-campus, and remote/online students are just a few of the opportunities that smart education brings to academic and training organizations (Rosak-Szyrocka & Tiwari 2023; Rosak-Szyrocka & Knop 2024; Rosak-Szyrocka, Żywiołek & Shahbaz 2024). The design and development of rich, multimedia learning content that is accessible via the Web and includes interactive presentations, video lectures, quizzes, tests, and instant knowledge assessment are additional advantages. Innovative smart classrooms that make it simple for faculty and students to collaborate locally and virtually are also being developed (Uskov et al. 2016). This chapter's objective is to examine the

concept of “Smart Universities”, with a focus on how traditional universities are transforming into smart campuses via the use of cutting-edge technologies like cloud computing, artificial intelligence (AI), and the IoT. Understanding how these technological advancements contribute to the creation of intelligent, efficient, and sustainable learning environments is the primary goal. To do this, the study used a bibliometric-analytic methodology. The Web of Science (WoS) database serves as the primary data source, and 626 open-access publications from 2020 to 2024 are highlighted using the VOSviewer program. Ingeniously incorporating cutting-edge technologies such as cloud computing, IoT, and AI into the idea of “Smart Universities”, this chapter presents a fresh framework that prioritizes adaptability and sustainability. It provides a thorough picture of the area by mapping current research trends and gaps using bibliometric analysis. This chapter further expands on the idea of integrating smart technology in learning settings by drawing a novel comparison between smart cities and campuses.

1.2 Literature Review

1.2.1 *The Smart University Issue*

Smart is the capacity to adapt to evolving circumstances (Ng et al. 2010). The term “smart” also applies to the capacity to exhibit or exhibit intellect (Malatji 2017). Smartness is defined as the capacity of the system to transform information input (stimuli) into action (response) (Favorskaya et al. 2015; Imbar, Supangkat & Langi 2020). After being coined to describe mobile phones, the term “smart” soon gained traction as a catchphrase. Originally, cell phones were called “smartphones”, and hence, a “smart device” was any gadget that could be controlled by a smartphone (Min-Allah & Alrashed 2020). Sustainable development is a key component that is promoted via smart efforts. High-tech innovations, like COVID-19 pandemic solutions, are combined with models and tools to make municipal services and infrastructures more accessible to citizens in “smart cities” (Makieła et al. 2022). Sustainable development and technology are further tools that smart cooperatives use to create value in this industry (Chawviang & Kiattisin 2022). In order to establish an ecosystem that unifies physical and digital places, smart campuses employ information and communication technology (ICT) to engage with stakeholders. To produce an atmosphere that is creative, productive, and sustainable, it creates services that are better, intelligent, and responsive (Villegas-Ch, Arias-Navarrete & Palacios-Pacheco 2020a; Min-Allah & Alrashed 2020).

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In 2020, the COVID-19 pandemic and its associated constraints prompted universities to expedite their digital transformation via the use of ICT, digital management, and online learning (Ramírez-Montoya 2020). By using technology in an environmentally friendly way, smart campuses want to enhance the livability and quality of life for all of its stakeholders (Clark & Eisenberg 2008; Durán-Sánchez, Álvarez-García & Del Río-Rama 2017; Durán-Sánchez et al. 2018).

The term “smart campus” was first used in 2000 (Kaneko et al. 2000), although there is still debate about its exact meaning, scope, and qualities. A university that uses technological innovation within its own walls to accomplish its goals is known as a Smart University (SU) (2021). The authors (Min-Allah & Alrashed 2020) proposed a definition of a smart campus that uses and integrates smart physical and digital spaces to establish responsive, intelligent, and enhanced services for the creation of productive, creative, and sustainable environments. They do this by building responsive, upgraded, and intelligent services for the establishment of creative, sustainable, and productive settings. As the foundation of a “smart campus”, some authors highlight the use of video-conferencing systems (Kaneko et al. 2000), smart card usage (Halawani & Mohandes 2003), cloud computing and the IoT (Nie 2013a), information platforms like wired and wireless and virtual private networks (VPNs), and pervasive sensor technologies (Chuling, Xie & Peng 2009c). Because it offers citizens a smart learning environment that prepares them to become smart workers, a smart campus is a crucial part of the framework for a smart city (Kwok 2015; *Smart learning in smart cities* 2017). Table 1.1 presents the definition of a smart campus.

In the present day, students bring a multitude of devices to universities, which they connect to the network and generate a vast quantity of data that can be used by the university management to improve services (Min-Allah & Alrashed 2020). IoT-based solutions were further categorized by the authors (Alghamdi & Shetty 2016) into smart campuses and smart universities. The deployment of apps that improve academic services and infrastructure is a hallmark of smart institutions. When a smart campus is established, organizations outside of the educational sector are viewed from an economic and financial standpoint. However, the phrases “smart campuses” and “smart universities” are interchangeable in the industrial sector, with “smart campus” growing in popularity (Chuling, Xie & Peng 2009a; Uskov 2015; Alghamdi & Shetty 2016; Fernández-Caramés & Fraga-Lamas 2019; Huang, Su & Pao 2019; Kaneko et al. 2000; Kwet & Prinsloo 2020).

A new university that uses a combination of faculty and ICTs to provide completely new standards for academic, research, commercial, and other

Table 1.1 The Definition of a Smart Campus

<i>Author</i>	<i>Definition</i>
Huang et al.	“The high level of digital campus”
Abuelyaman	“Deploys smart teachers and gives them smart tools and ongoing support to do their jobs while assessing their pedagogical effectiveness using smart evaluation forms” and at the same time “provides its students with reliable services anytime and anywhere access to the Internet is available”
Xiong	“Smart Campus is to use the Internet of Things, data fusion, cloud computing, data mining, and other information technologies, to integrate the independent business systems and resources of schools into an organic whole with highly collaborated capability, perception, as well as service ability to support school development”
Liu	“IoT, cloud computing, AI, and data analysis are the technologies that underpin a smart campus’s operations. Each of these technologies turns into a cornerstone of the smart campus, which is intended to recognize and cater to the demands of its constituents. Additionally, the campus needs to serve members in a natural setting that is sustainable. Each element acts and concentrates on a certain activity in order to accomplish this aim. Without a human or a computer, the Internet of Things (IoT) communicates with campus residents via networks of sensors and actuators”
Tikhomirov	“Smart University is a concept that involves a comprehensive modernization of all educational processes. The smart education is able to provide a new university, where a set of ICT and faculty leads to an entirely new quality of the processes and outcomes of the educational, research, commercial and other university activities. The concept of Smart in education area entails the emergence of technologies such as smart boards, smart screens and wireless Internet access from everywhere”
Kwok	“A new paradigm of thinking pertaining to a holistic intelligent campus environment which encompasses at least, but not limited to, several themes of campus intelligence, such as holistic e-learning, social networking and communications for work collaboration, green and ICT sustainability with intelligent sensor management systems, protective and preventative health care, smart building management with automated security control and surveillance, and visible campus governance and reporting”
Nie	“Smart campus is the outcome of the application of integrating the cloud computing and the internet of things. The application framework of smart campus is a combination of IoT and cloud computing based on the high performance computing and internet”

Source: Own study.

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activities may be created via smart education. The rise of technology like smart displays, smart boards, and ubiquitous wireless Internet connection is what the term “smart” in education refers to (Tikhomirov, Dneprovskaya & Yankovskaya 2015). A university went through three phases before becoming a smart campus (Nie 2013b) (Figure 1.1).

A university’s teaching and learning activities are conducted in a typical manner during the traditional campus phase. In addition to exchanging the course material, faculty and students must communicate face-to-face in the classroom. The method of teaching and learning activities has changed in tandem with the growth of ICT and its use in the educational environment. The most prevalent example of how an ICT-adopting institution becomes an e-campus, or digital campus, is when it uses the Internet to spread course content, including the usage of online learning. Based on digital campus, intelligent campus evolved to become the pinnacle of a university’s academic information system (Nie 2013b; Liu, Zhang & Dong 2014). The ability of smart campuses to quickly adjust and respond to change in order to meet user demands and to use the variety of intelligence ingrained in the technologies that enable them is a fundamental characteristic. The most prestigious universities in the world are quickly adopting the concepts and methods surrounding smart universities and smart education because these days’ advanced, high-tech smart technologies, systems, and gadgets offer academic and training institutions previously unheard-of opportunities in terms

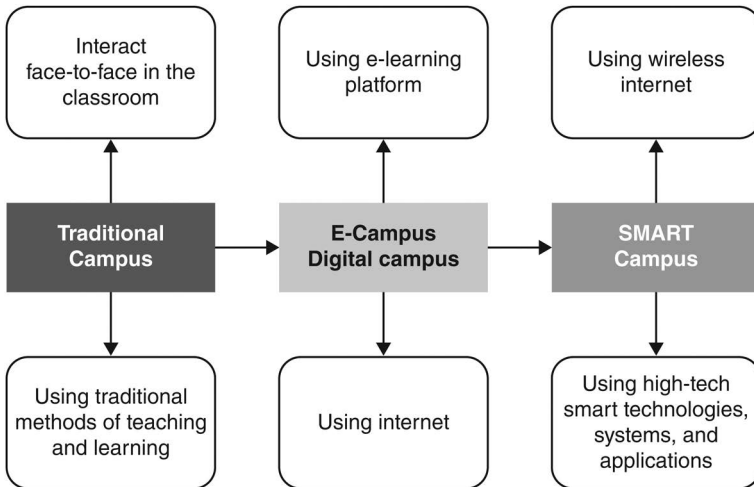


Figure 1.1 A university phase to become smart. (Source: Own study based on Nie (2013a) and Liu, Zhang and Dong (2014).)

of improved teaching standards and anticipated learning/training results (Shi et al. 2003; Shum, Liao & Chang 2006; Xie et al. 2006; Maria, Vasilis & Grigoris 2012; Uskov, Bakken & Pandey 2015; Uskov et al. 2018a; Uskov et al. 2018b). The authors (Uskov et al. 2018a) contend that in addition to cutting-edge hardware and software features and creative, contemporary teaching and learning approaches, smart universities as smart systems should place a strong emphasis on the “smart” aspects of smart systems. The primary difference between a traditional university and a Smart University is the incorporation of new technologies, such as e-learning, the IoT, cloud computing, big data, and renewable ICT. Figure 1.2 shows the classification of smartness levels of a smart system.

A university is regarded as intelligent due to its integration of these emerging technologies (2021; Rosak-Szyrocka et al. 2022b, 2024; Rosak-Szyrocka 2024b). In order to implement, maintain, and actively utilize distinctive “smartness” features, such as adaptation, sensing, inferring, self-learning, anticipation, and self-optimization, a smart university must have numerous additional “smart” components in addition to the numerous components of a traditional university (Heinemann & Uskov 2018). A university is considered

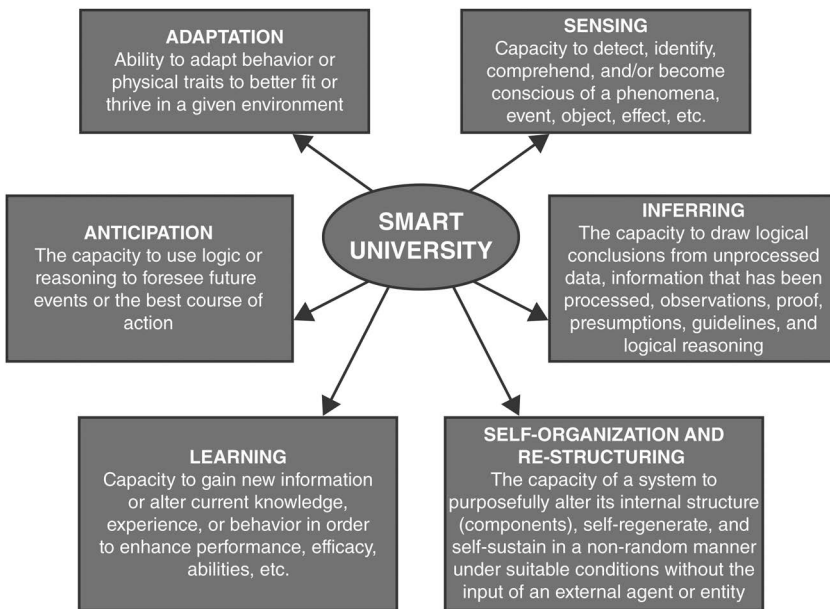


Figure 1.2 The classification of smartness levels of a smart system. (Source: Own study based on (2021) and Uskov et al. (2018a).)

intelligent if it can apply its knowledge to research, resolve conflicts of interest among stakeholders, and leverage the public's intelligence to enhance the system's intelligence. Smart Universities operate similarly to smart cities, which provide their residents with intelligent services and applications to enhance their quality of life. In order to transform a conventional university into a smart campus, it is imperative to implement the smart campus framework/model (Imbar, Supangkat & Langi 2020). For example, the University of Malaga (Fortes et al. 2019) implements sophisticated communication technologies within its IoT infrastructure to establish a smart campus that facilitates both innovative educational and research initiatives and effective environmental management. The University of New South Wales in Australia has also successfully implemented a pilot IoT project for four smart campus use cases: classroom attendance, student study space usage, parking lot occupancy, and bus-stop waiting management (Sutjarittham et al. 2018). Smart cities often include smart universities as essential components, and these institutions are often located in similar socioeconomic, environmental, and geographic contexts. As such, they have similar transportation networks, services, infrastructures, communication channels, and even issues and needs (Dong et al. 2020). As each of the existing smart campus initiatives is tailored to a university's specific requirements, there isn't a single model that can be used when building a smart campus. Emphasis is placed on the key elements of a smart campus. Physical infrastructure, the integration of smart technology with the smart grid, data analysis, and service delivery based on the data are the key components of a smart campus (Min-Allah & Alrashed 2020). According to Chuling, Xie and Peng (2009a), three patterns were found that fit the description of a smart campus:

1. technology-driven,
2. initiatives based on the ideas of smart cities, and
3. initiatives driven by business processes.

Technology, particularly the IoT and ICT, powers smart campuses, raising the bar for information quality in schools and universities. A wide range of technologies enable the prompt and effective digitization of processes, education, research, and services (Luo 2018; Tian et al. 2018; Xu, Wang & Yu 2018; Celdran et al. 2020; *Caracterización de la situación actual de las tecnologías inteligentes para una Universidad inteligente en Colombia/Latinoamérica* 2020). In order to maximize the quality of life for its residents through the use of cutting-edge technologies like ICT and IoT, smart cities encourage the integration of social, economic, and environmental awareness into a well-performing city.

These cities are primarily based on smart dimensions (economy, people, governance, mobility, environment, and living) (Giffinger et al. 2007; Caragliu, Del Bo & Nijkamp 2011; Caballero et al. 2014; Silva-da-Nóbrega, Chim-Miki & Castillo-Palacio 2022). As an advanced model of digital and sustainable colleges, the smart campus is a component of smart city initiatives that use sustainability and technology (Janssen & Prasetyowati 2018). Smart campuses, which have comparable structures, may serve as a miniature version of a smart city (*Making a smart campus in Saudi Arabia* 2008; Alvarez-Campana et al. 2017; Vasileva et al. 2018; Yagol et al. 2018; Fortes et al. 2019). Parallels and connections between the campus and the city are anticipated, as university campuses may be compared to small cities in many ways. The university is a city within a city (Vasileva et al. 2018). According to the integration of the smart city idea, a smart campus is said to be comparable to a smart city in that both face various issues that cities and universities face. The smart campus employs contemporary technology to facilitate the performance of multiple duties by a variety of users, including students, employees, and visitors, in multifunctional buildings, all within the same paradigm (Mattoni et al. 2016). The smart campus is perceived as a small, self-contained city in certain respects, including the quantity of functions, users, activities, and connections (Ardito et al. 2019). In order to enhance processes via information exchange methods, the organizational process viewpoint focuses on substituting antiquated manual services with intelligent ones (Quiroga Alonso & Pérez Donsión 2016; Nan et al. 2018). To accomplish smart management and service on University, the management should also provide individualized advice and support for certain activities depending on user needs (Guo 2018; Yang et al. 2018). A smart campus' basic idea is to improve it via the effective use of its resources (Ahmed et al. 2018) and the use of a range of intelligence technologies to provide high-quality (Abouhawwash, Rosak-Szyrocka & Gupta 2024) and intelligent services to the campus and surrounding communities (2021). This strategy lowers operating expenses while improving living standards. A range of sensor technologies are utilized to deploy intelligence, enabling reporting into all areas of campus life, such as learning, social interaction for teamwork, intelligent building management, and smart environments, autonomously. A smart campus reduces its total energy consumption by optimizing the upkeep and use of its physical infrastructure via the use of digital technology. The main concept of a smart campus is the university's integration of a range of cutting-edge intelligence technology to enhance overall quality of life, graduate quality, and student performance. This is accomplished by offering user-friendly, useful, and dynamic information technology services that provide real-time automation and reporting.

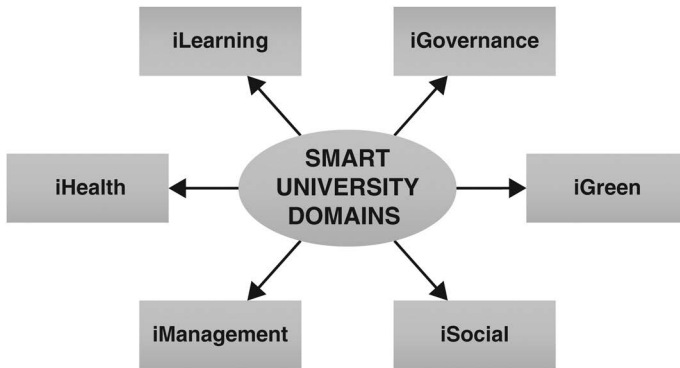


Figure 1.3 Smart University domains. (Source: [Imbar, Supangkat and Langi \(2020\)](#).)

The idea encompasses a wider variety of topics than only educational activities, including social interaction, the environment, office administration, and energy saving ([Imbar, Supangkat & Langi 2020](#)). The notion of smart cities has surfaced as a current literary fad, with government, academia, and business serving as the main domains of smart cities ([Kaneko et al. 2000](#)). There are six intelligence domains that a university has to have in order to highlight the qualities of a smart campus ([Figure 1.3](#)) ([Imbar, Supangkat & Langi 2020](#)). iLearning is the study of university learning processes where the primary players are the lecturers and the students. The way that learning progresses is greatly influenced by the usage of ICT. iGovernance satisfies stakeholder requirements while concentrating on responsible university governance. The “green campus” component of iGreen focuses on the amount of carbon pollution present across the whole institution.

This pertains to the issue of climate change caused by air pollution. The primary focus of iHealth is the health of students living on campus. iHealth depends on maintaining, observing, and guaranteeing the overall health of the campus community. This domain supports the development of a healthy environment by being in line with iGreen. Because social networking technology is being used more and more, the iSocial domain has emerged. Unquestionably, people utilize social networks these days to document their sentiments and daily status updates in addition to their profiles. Another social activity that inevitably takes place is interactions between students and professors. A university’s social process includes collaborative learning, which is one of the iLearning domain’s key emphases. iManagement places a strong focus on university general management. The domain of iManagement encompasses the university’s physical assets and personnel, including

staff, teachers, students, and visitors. It includes elements like automatically turning on lights, regulating a building's temperature, installing doors that can only be accessed with the right permission, and other aspects of intelligent building management. Several aspects should be included in a smart campus system, including the following:

1. face recognition to prevent crime or track individuals in a certain region,
2. people monitoring or mobilizing to keep an eye on human distribution during particular periods,
3. smart cards for non-cash transactions and parking permits,
4. attendance tracking for educational activities.

VPN, IoT devices, and ubiquitous computing have further developed the concept of a smart campus. Radio-frequency identification (RFID), IoT, cloud computing, 3D visualization technology (augmented reality), sensor technology (motion, temperature, light, humidity), mobile technology (including Near Field Communication—NFC, Quick Response—QR code, Global Positioning System—GPS), and Web services are the technologies that have been identified for a smart campus (Chuling, Xie & Peng 2009b). Table 1.2 shows the technologies and software used by SU.

1.2.2 Bibliometric Analysis with Using Wosviewer Analysis

Bibliometric studies have recently been frequently conducted using visualization software, which can generate node-link maps that enable us to intuitively observe the publication outputs, striking points, and all other aspects of a research area. The data was meticulously analyzed using VOSviewer software in this investigation. VOSviewer enables the visualization of the formation of bibliometric networks. The software version 1.6.18 was implemented. Van Eck and Waltman (van Eck & Waltman 2010) developed VOSviewer, a literature visualization software that offers the capability of displaying cluster analysis results. Seven nodes and links are the representations of elements in information maps generated with the VOSviewer. The weight of the analysis components is directly proportional to the weight of nodes and their identifiers, which include countries, organizations, authors, citations, and keywords. The data was analyzed in terms of keywords and countries of publication after publications on triage were retrieved from WoS. The relationship between components is influenced by the decoupling between nodes (van Eck & Waltman 2010; VOSviewer manual 2011; VOSviewer and bibliometrix 2022).

Table 1.2 The Technologies and Software Used by SU

<i>Software Systems</i>	<i>Technologies</i>
Web-lecturing systems for learning content production and pre-class exercises that include video and computer screen capture features	Internet-of-Things technology Cloud computing technology Web-lecturing technology Collaborative and communication technologies
Intelligent classroom technologies for documenting in-class activities	Ambient intelligence technology
Software systems for smart cameraman	Smart agent technology
Systems for exchanging learning materials and documents and facilitating smooth collaborative learning in smart classrooms for both local and distant students	Smart data visualization technology Augmented and virtual reality technology
Web-based collaborative solutions for one-to-one and many-to-many audio/video communication	Computer gaming (serious gaming) technology Remote (virtual) labs
Group discussion hosting, participation, formation, and evaluation systems (for both local and distant students)	3D visualization technology Wireless sensor networking technology
Systems for automatically playing back lectures and class activities to study and complete after-class tasks (by both local and distant students)	RFID (radio frequency identification) technology Location awareness technologies (indoor and outdoor)
Digital learning material repositories, learning portals, and online resources	Sensor technology (motion, temperature, light, humidity, etc.)
Intelligent teaching analytics systems and intelligent learning analytics	
Motion tracking technologies for speakers and instructors	
Systems for voice and speech recognition	
Voice-to-text platforms	
Systems for synthesizing text to speech	
Systems for synthesizing text to speech	
Systems for recognizing emotions	
Systems for recognizing gestures and activities	
Systems for situational awareness	
Systems for automatic translation	
Cyber-physical systems with intelligence	
A range of intelligent software agents	
System(s) for monitoring light, power	

Source: Own study.

This section's main objective is to utilize bibliometric analysis to look at how the phrase "Smart University" has changed over time in the subject of education. We employ the advanced retrieval function of WoS to capture data from foreign literature, select the core collection of WoS as our database,

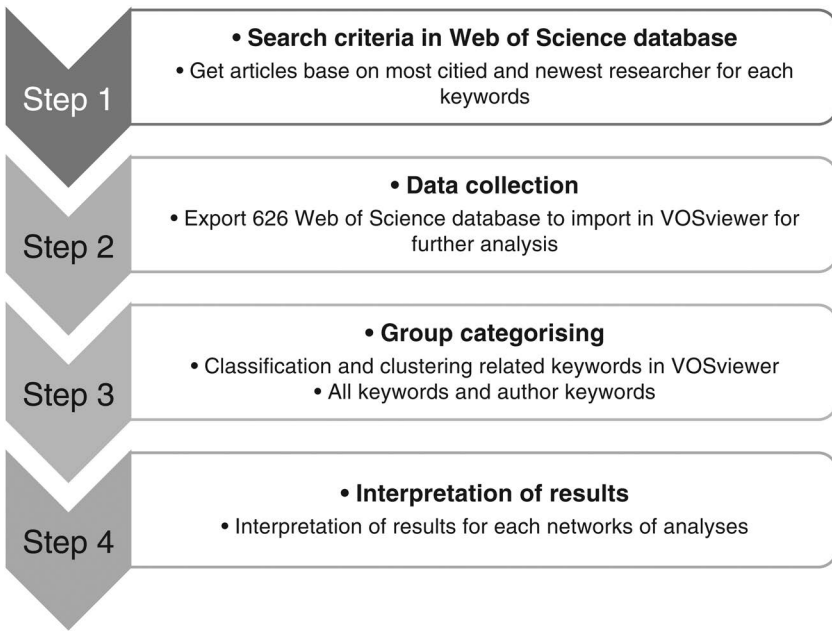


Figure 1.4 Steps in bibliometric analysis. (Source: Own study.)

and align the retrieval time span with that of domestic literature. We utilized the search terms “Smart University” and “education” to identify 626 open-access manuscripts in English as valid samples. The period of 2020–2024 is the focus (Figure 1.4).

Table 1.3 presents selected articles on Smart University published in the WoS database.

Each treemap chart in Figure 1.5 corresponds to a specific journal category.

Education Educational Research: This category is the most prominent, with 149 occurrences, suggesting a strong emphasis on educational research within the dataset. This may include research on educational technology, policy, learning outcomes, and pedagogy.

Information Systems in Computer Science: The presence of 53 occurrences indicates a substantial level of research interest in the intersection of information technology and its applications, which may be applicable in educational environments, as indicated by the data.

Environmental Focus: Environmental Sciences and Environmental Studies have 49 and 43 occurrences, respectively, indicating a persistent interest in environmental issues. This interest may be indicative of interdisciplinary research that involves education, sustainability, and technology.

Table 1.3 Review of Recent Manuscripts about Smart University—Web of Science Database.

<i>Authors</i>	<i>Title</i>	<i>Journal</i>	<i>Objective</i>	<i>Methodology</i>	<i>Findings</i>
Mbombo & Çavuş [13]	<i>Smart University: A University in the Technological Age</i>	<i>TEM Journal-Technology Education Management Informatics</i>	The manuscript aims to evaluate the influence of e-learning and big data technologies on educational institutions, learners, and instructors, emphasizing the potential advantages and constraints of incorporating such innovations. The objective of the investigation is to articulate effective strategies for universities to adapt to the demands of the technological era.	The concept of a Smart University was investigated through a comprehensive literature review strategy in the methodology.	By enhancing teaching techniques and customizing instruction, the research contends that incorporating e-learning and big data into higher education improves student results. But it also emphasizes practical difficulties, especially with regard to the need for strong data security steps.

(Continued)

Table 1.3 (Continued)

<i>Authors</i>	<i>Title</i>	<i>Journal</i>	<i>Objective</i>	<i>Methodology</i>	<i>Findings</i>
Dalla Gasperina et al. [91]	Smart practices in HEIs and the contribution to the SDGs: implementation in Brazilian university	<i>International Journal of Sustainability in Higher Education</i>	With a focus on its links to the sustainable development goals (SDGs), this article seeks to showcase the advantages of smart practices in higher education institutions.	The three steps of the methodology are as follows: first, a global search and evaluation of smart practices at universities; second, a campus-level identification of smart practices in a southern Brazilian university; and third, a presentation of the advantages of smart practices and how they relate to the SDGs.	The findings demonstrated that, worldwide, the environment—more especially, waste reduction—is the subject of wise practices in higher education. Regarding this case study, the advantages of putting smart practices into reality mostly pertain to SDGs 4 and 9, particularly in light of the optimization of campus infrastructure management and features of teaching technology for the new classroom models.
Silva et al. [71]	A smart campus framework: Challenges and opportunities for education based on the sustainable development goals	<i>Sustainability</i>	In order to provide decision-makers with a list of priorities, this study attempts to pinpoint the most important components as well as the most serious shortcomings in the smart campus dimensions and its factors from the perspective of the user.	An integrated smart campus framework in a Brazilian university was tested using an importance-performance analysis (IPA) conducted using IBP SPSS 26, which had previously been verified by Latin American specialists.	This study came to the conclusion that technical features alone could not support the smartization process. Universities should respond in a sustainable, socially and technologically responsible way to the demands of the labor market as well as the current and future requirements of society.

(Continued)

Table 1.3 (Continued)

<i>Authors</i>	<i>Title</i>	<i>Journal</i>	<i>Objective</i>	<i>Methodology</i>	<i>Findings</i>
Mazutti et al. [92]	Smart and learning campus as living lab to foster education for sustainable development: an experience with air quality monitoring	<i>International Journal of Sustainability in Higher Education</i>	With an emphasis on the smart and learning campus, this study seeks to report on an experience with air quality monitoring and examine its implications for the university environment regarding ESD and sustainable development goal (SDG) integration.	Three contaminants that are directly connected to vehicle emissions were the focus of the University of Passo Fundo's main campus air quality testing. A website that included information on health issues related to air pollution, primary sources of emissions, and methods for reducing them also displayed the air quality index (AQI).	The findings demonstrated the connection between traffic emissions and the decline in air quality, as well as the possibility of teaching pupils about sustainability education by placing them in an intelligent learning environment.

(Continued)

Table 1.3 (Continued)

<i>Authors</i>	<i>Title</i>	<i>Journal</i>	<i>Objective</i>	<i>Methodology</i>	<i>Findings</i>
Dai et al. [93]	A model for assessing student satisfaction with smart classroom environment in higher education	<i>Journal of Computer Assisted Learning</i>	This research suggested the smart classroom environment satisfaction model, which is based on TAM and ACSI models, to evaluate students' happiness with smart classrooms in higher education.	A survey measuring student satisfaction with the smart classroom setting was completed by a sample of 1979 Chinese college students who studied in such an environment. Additionally, the study used a structural equation modeling analysis to examine students' inclinations toward smart classroom settings.	The findings demonstrated a substantial correlation between subjective perception characteristics such as students' perceived value (PV), user experience, and perceived expectations (PE) and student happiness with the smart classroom environment after usage. It showed that whereas PE indirectly impacted OS by its favorable influence on user experience, OS was indirectly impacted by user experience's beneficial impact on PV.

Source: Own study.

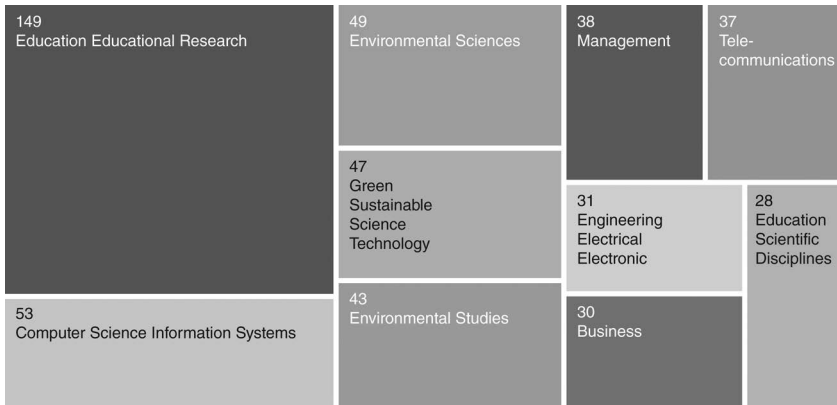


Figure 1.5 Treemap chart corresponds to a certain journal category. (Source: <https://www.webofscience.com/>, access: 20.08.2024.)

Green Sustainable Science Technology: This category, which has been referenced 47 times, is likely to concentrate on sustainable practices and technologies, emphasizing the integration of green technologies in a variety of domains, including educational infrastructures.

Technical and Business-Oriented Research: Engineering Electrical Electronic (31 occurrences) and Business (30 occurrences) represent a substantial corpus of work that pertains to the technical aspects of electronic engineering and business studies, respectively. These areas may be especially pertinent in research that connects technology to its commercial applications or operational efficiencies. A focus on administrative, organizational, and communication aspects within the broader scope of the selected publications is suggested by the significant occurrences of Management (38 occurrences) and Telecommunications (37 occurrences). These areas are essential for comprehending the manner in which organizations manage technology and communication infrastructures, particularly in educational environments.

Interdisciplinarity: The publications' multidisciplinary approach is indicated by the diverse areas they cover. The cross-disciplinary concentration on sustainability in education is indicated by the significant presence of environmental and sustainable sciences in conjunction with educational research.

Integration of Technology: The substantial presence of computer science, telecommunications, and electronic engineering suggests a concentration on the technological aspects of education and the potential for the development and implementation of new technologies in educational environments.

Current Research Trends: The focal areas may be indicative of contemporary academic research trends, particularly the integration of technology and

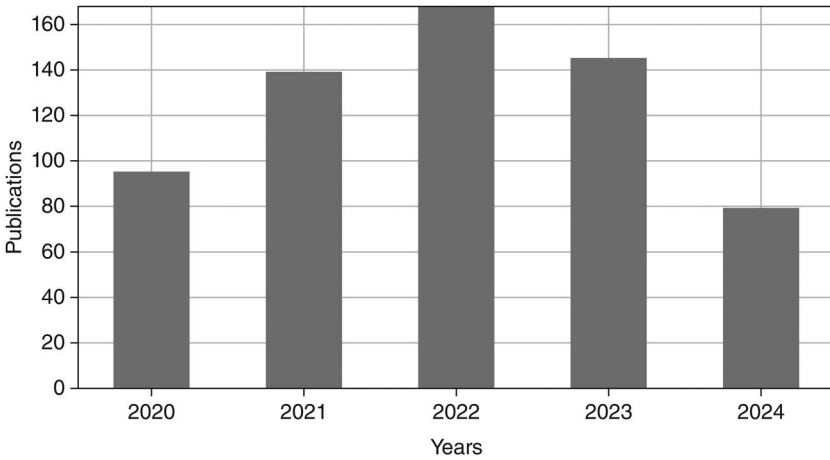


Figure 1.6 Number of publications within smart university. (Source: Own study.)

sustainability in education, which is consistent with global educational objectives and technological advancements.

Figure 1.6 shows the number of publications within Smart University in the 2020–2024 years.

The analysis of Figure 1.6 shows that the largest number of publications related to the smart university issue took place in 2022, with a total of 168. In 2023, the number of publications was 145; in 2021, the number was 139. Figure 1.7 shows the number of citations within Smart University in the 2020–2024 years.

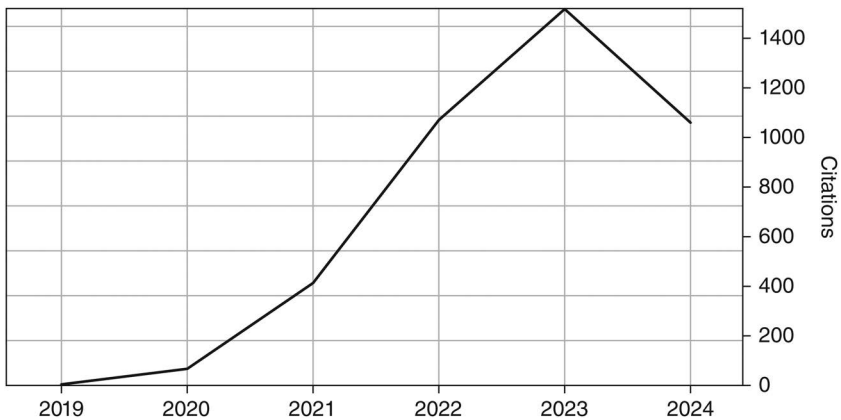


Figure 1.7 The number of citations within Smart University issue in the 2020–2024 years. (Source: Own study.)

“smart learning”, and “distance education”. The violet cluster includes words such as “mobile”, “learning”, “self-efficacy”, “PLS-SEM”, “technology”, “work engagement”, and “educational technology”. The Azure cluster includes words such as “smart city”, “smart manufacturing”, “industry 4.0”, “sustainability”, “digital transformation”, and “engineering education”. Figure 1.9 shows co-authorship countries. Figure 1.10’s analysis reveals the existence of six clusters. China dominates the violet cluster, which includes countries like Ghana, Iran, Pakistan, and South Korea. Saudi Arabia dominates the green cluster, which also includes Egypt, Spain, Germany, Mexico, and Italy. The USA dominates the red cluster, followed by Canada, France, South Africa, Brazil, Portugal, and Romania. India dominates the blue cluster, followed by England, Ukraine, Bangladesh, Vietnam, Australia, and Japan. Russia dominates the Azure cluster, followed by Taiwan and Thailand. Malaysia dominates the orange cluster, followed by Indonesia. Oman, Iraq, Jordan, Turkey, and Arab Emirates create yellow cluster.

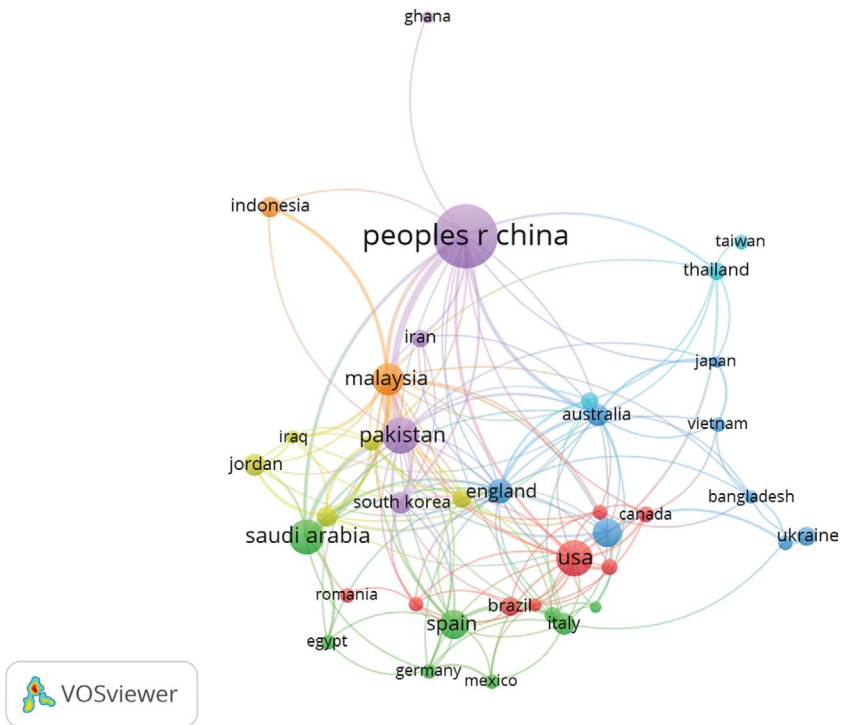


Figure 1.10 Co-authorship countries. (Source: Own study.)

1.3 Discussion

Universities have adopted new technology and data-driven solutions to enhance their campuses, much as cities have, with the notion of “smart” campuses becoming more popular. In many respects, campuses resemble little cities. They are working more and more to solve related issues and provide their consumers with better experiences (Vasileva et al. 2018). In the present day, it is imperative for conventional universities to evolve into smart (modern and intelligent) universities. This is evident in the wake of the global pandemic, which has resulted in the closure of traditional universities, while smart universities continue to operate (Roza 2021). Active learning is made easier by the use of technology at universities, which piques students’ interests and puts them in the lead role in their education (Villegas-Ch, Arias-Navarrete & Palacios-Pacheco 2020b). Currently, academic institutions are working to improve their methods of instruction by meeting the needs of their students. One approach to addressing these requirements is to employ ICTs as allies. ICTs enhance processes and manage vast quantities of information that universities can leverage to enhance educational models and management (Pagliaro et al. 2016). By enabling universities to improve their operations and services and meet their sustainability goals, a smart university is a new trend that has the potential to completely change the way that education is delivered. Due to the widespread use of cutting-edge technologies, a smart university is an important idea that integrates technology into higher education. This chapter’s findings indicate that the conversion of conventional universities into “Smart Universities” represents a significant advancement in the history of tertiary education. Through the incorporation of cutting-edge technologies like cloud computing, AI, and the IoT, universities may establish more responsive, efficient, and sustainable learning environments. This change improves education quality while also following worldwide trends toward sustainability and digitization. The move to smart campuses does, however, come with a number of difficulties, such as the demand for a significant capital expenditure in technology and the ongoing need to adjust to quickly evolving technological environments. The results highlight the significance of further investigation and the creation of workable plans to assist colleges in this digital shift. In the end, the research shows how smart institutions have the power to greatly enhance student learning and further larger social objectives. Figure 1.11 displays word clouds for top words connected with smart university issue. The findings’ analysis emphasizes the significance of ideas like sustainability, student engagement, and educational



Figure 1.11 Word clouds for top words connected with smart university issue. (Source: Own study.)

outcomes while simultaneously highlighting the critical role that technology, including IoT and AI, plays in the creation of smart campuses. According to the bibliometric study, contemporary research activities are centered upon digital transformation, sustainability, and educational technology. Teaching and research activities are facilitated by a digital campus, which capitalizes on IoT technologies (Kirkup & Kirkwood 2005; Cavus et al. 2022). Education is crucial for the ongoing growth and livability of a city since it fosters innovation and creativity (*Smart learning in smart cities* 2017). There are the following advantages of a smart campus (Cata 2015; Alghamdi & Shetty 2016; Rosak-Szyrocka et al. 2022a):

- Monitoring the movement of individuals with the potential to open or close pathways to locations on campus, as well as illuminating corridors and halls.
- Locating and indicating the direction of travel to a specific location on campus (e.g., faculty, classrooms, library, publishing house, and dining hall) to facilitate traffic flow.
- Facilitate the prevention of accidents and disasters by consistently monitoring the institution's corridors for noise, temperature, humidity, smoking, and light. The implementation of a variety of statistical analyses that are beneficial in the development of strategies to enhance the quality of

education in a controlled environment with regard to safety and environmental factors.

- Decreased electricity consumption.
- Achieving the inventory of technology and equipment with ease; fostering an environment that encourages the socialization of all university community members.
- Utilizing the data that has been collected by others to develop a variety of practical applications.
- Encouraging intelligent energy management by cutting down on electricity consumption through campus hotspots and automatic lighting controls along corridors and rooms based on people's movements in this area.
- Using gathered data to create practical applications to improve business process automation.
- Streamlining the technology and device inventory process.
- Fostering an innovative and dynamic environment that promotes social interaction among all campus communities, particularly between instructors and students.
- By continuously monitoring disturbances, temperature, humidity, and smoke in campus areas to ensure a safe learning environment, real-time disaster response and warning services are provided via the effectiveness of surveillance systems.

Smart University operates on the basis of the “4T” components: technologies (digital technologies, free educational content access for students, teacher and student feedback, administrative task automation), tactics (student-centered model, which is based on the appropriate facilities), talents (smart students who can grow and improve themselves in the future professional field and competent teachers with a complex set of professional competencies), and traditions (traditions that are supported by modern requirements with prospects for the future) (Figure 1.12) (Potapchuk et al. 2022).

Taking into consideration the experience and traditions of classical education, the use of smart technologies permits the adoption of strategies for structuring the activities of a contemporary university, which seek to improve the professionalism of outstanding students and instructors. Open distance learning will be accessible and a contemporary learning environment will be facilitated by the Smart University approach. SU concept's main advantage is that it emphasizes more than just technology. The use of professional development centers, academic mobility programs, and online learning systems is all made possible by technological methods. In light of such circumstances,



Figure 1.12 Word clouds for 4T SU components. (Source: Own study.)

a contemporary smart university's job is to help students build their core abilities (life, career, technology, and communication), 21st-century human abilities, such as collaboration (leadership, diversity knowledge, tolerance for individual differences, etc.). According to the authors (Potapchuk et al. 2022), putting the Smart University idea into practice guarantees the accomplishment of academic objectives and the development of a friendly, open, and engaged community of educators, learners, candidates, graduates, and others who comprehend and value the university's objectives and core principles. A smart university is an idea that is modeled after contemporary university that combines efficiency, adaptability, and progress-orientedness with a cooperative and inventive culture.

Prospective investigations for this chapter may concentrate on the pragmatic use of smart university technologies in various international settings, scrutinizing the ways in which other locales modify these technologies to suit their particular requirements and limitations. Studies may also look at how smart universities affect sustainability, institutional effectiveness, and student results over the long run. This would provide empirical support for the theoretical frameworks covered in this chapter.

1.4 Conclusion

This chapter has examined how traditional universities are changing into smart campuses by using cutting-edge technology like cloud computing,

AI, and the IoT. The results show that these developments are not just new ideas but also crucial building blocks for flexible, effective, and long-lasting learning environments. A paradigm shift in higher education is represented by the idea of “smart universities”, which embrace flexibility, interconnection, and data-driven decision-making in place of more conventional approaches.

Smart universities play a role that goes beyond their physical campuses. They play a major role in creating a smarter, more connected future by encouraging innovation, advancing sustainability, and empowering the upcoming generation of students. Smart universities have a big influence on stakeholders because they give students individualized learning experiences, give teachers cutting-edge teaching resources, and help administrators better manage campuses and maximize resources. Furthermore, their contributions go beyond scholarly confines, supporting a sustainable culture and complementing international smart city projects. This change is not without difficulties, though. Significant obstacles include the digital divide, cybersecurity issues, and the high expenses of deploying smart technologies. Governments, the commercial sector, and educational institutions must work together to address these problems in order to guarantee fair access, strong security, and well-timed infrastructure improvements. The comparative analysis of smart campuses in various cultural and geographic situations should be the focus of future research. It is also crucial to conduct long-term assessments of their effects on societal growth, environmental sustainability, and educational outcomes. Furthermore, as the digital transition quickens, ethical issues like data privacy and digital inclusion need to be carefully taken into account. In the future, smart universities could develop into centers of innovation that transform the educational process and tackle urgent social issues. In a world that is changing quickly, they serve as shining examples of flexibility, sustainability, and forward-thinking. All stakeholders must accept these changes, give inclusive designs first priority, and never stop innovating if this goal is to become a reality.

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