

# From traditional to a smart campus: a framework sketch for King Abdulaziz University female campus

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## Abstract

Technology has completely enhanced how we live our lives and how people learn, work, and shop. Higher Education institutions are not immune to these challenges, they must keep up with changes in technology and society or be left behind. King Abdulaziz University (KAU) works to close the gap between the expectations of society and the realities of how people learn. To do so, we must take a step back and critically assess where we are today. This study aims to propose a sketch of the I-campus. The smart campus sketch in this study aims to allow KAU to use smart technology with existing infrastructure to enhance learning, services, decision-making, and campus sustainability, among other things. This study proposes a smart campus sketch based on smart city concepts. This proposed project aims to preserve and enhance KAU's status as an institution of high-quality higher education that meets the aspirations of its community. Using the existing female campus map, the study believes that KAU could adopt all or some of the sketched smart campus criteria suggested in this study.

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## 1 introduction

A group of businessmen established King Abdulaziz University (KAU) in 1967 as a private organization working to spread knowledge and meet the Western Region's need for higher education. To serve as a beacon of Islamic sciences and jurisprudence, the College of Shari'ah (Islamic Law) and Islamic Studies in Makkah, which was the oldest and only operating college in Saudi Arabia, and was founded in 1949, was united with King Abdulaziz University, in 1974, by the order of King Faisal, KAU became a public institution to provide excellent quality education for the Arab world.

In 1974, KAU became a public institution. King Abdulaziz University is one of the eight universities in Saudi Arabia under the Ministry of Higher Education. The university offers all major subjects (e.g., Science, Engineering, Medicine, Arts, Economics, and Business). According to [1], KAU was one of the first universities to use computer technology in its library. It was also the first university in Saudi Arabia to develop and implement computer technology in office work, such as admissions, registration, course schedules, and grade reports in Arabic. The university computer center was established in 1976 to provide many services, including computer hardware, software, and maintenance of colleges and other branches [2]. Most Saudi universities' central libraries started as college libraries merged to form a large library that provides services to the whole university community and its attached college libraries.

The campus we have today is the physical manifestation of this vision. Over 5 decades we have grown from a modest beginning to become one of the major higher education institutions in

Saudi Arabia. The female section of KAU is considered one of the first campuses that embraced and encouraged girls' education in the Kingdom of Saudi Arabia. Therefore, it bears a great deal of responsibility for keeping pace with the latest educational developments, which guarantees its position in the ranks of prestigious universities. If we take utilizing information and communication technologies into account, the female campus at KAU has come a long way in this field. Yet, the technologies that are being applied are not enough to help classify this campus as smart.

A smart campus is not just about the number of technologies being used. It is about their effects on reducing the operational costs, the time spent, the efforts, and improving sustainability. Universities act as small cities with their buildings, health care systems, transportation services, etc. A university campus is regarded as a controlled representation at the city scale. Therefore, it is logical to implement the smart city concepts when intending to transfer a traditional campus into a smart one. Whereas in the literature, the idea of a "smart city" emphasizes people, technology, and institutions from a variety of angles [3], and according to [4] it includes better-enhanced Life for individuals through smart health systems and institutes, independent economy and government, smart transportation, B101, and other efforts.

As KAU is one of the most important universities in Saudi Arabia, the main goal of the KAU smart campus sketch is to enhance campus services and facilitate teaching, learning, and research. In addition to eliminating all barriers, the campus community can access all services more easily. As the new generation of students is digital natives whose expectations exceed traditional learning services. This study aims to shed a light on the importance of smart campus transformation. Implementing smart camps can benefit the KAU community by improving student experiences and outcomes, enhancing college campus safety, boosting the university's reputation, and lowering costs.

The main reason for a smart university is to achieve intelligent management and service on campus. this study aims to conceptualize an intellectualized campus with integrated living, learning, and working environments to reach.

## 2 Literature review

### 2.1 Smart campus – definition

Although several research works have been conducted to address the Smart Campus definition since it first appeared in literature, there has not been a universally agreed upon one. [5] defined the basic concept of a Smart Campus as an effort to integrate a set of advanced intelligent technology by the university to improve the performance, the quality of the graduates, and the ease of life through the provision of information technology services that are valuable, dynamic, and user-oriented to support automation and reporting in real-time, not only for learning activities but covering a broader aspect, including social interaction, environment, office management, energy saving, etc. This also aligns with [6], the definition of a Smart Campus [7] as an educational environment permeated with technological solutions for smart services to improve educational outcomes while meeting stakeholders' interests, with extensive interactions with other interdisciplinary areas in the context of smart cities. According to [8], A smart campus is defined as the integration of cloud computing and the Internet of things, which supports university management, teaching, research, and other practices. A smart campus adheres to smart city concepts and copes with the same challenges. Whereas [9] stated that, Campuses have also been granted the designation of "smart" in the education sector, with the idea of using cutting-edge information and communication (ICT) technologies to improve the effectiveness and efficiency of campus activities. Therefore, Smart

Campus can be defined as the integration of computing in the cloud and the Internet of things (IoT), which helps manage, teach, research, and enhance smart-university services.

## **2.2 Smart campus – applications**

[10] discussed the already implemented smart internet of things-based campus applications and systems by outlining the traits of intelligent campuses, stressing the key characteristics as well as the main shortcomings. This study provided insight into how a smart campus can be recognized through an internet of things -enabled computing environment to build an infrastructure for applications to develop and provide value-added services by utilizing cooperative sensing of environmental entities, i.e., people, spaces, machines, etc. by countless already applied internet of things based campus application testbeds from these subject areas for example, waste, water, smart grids, learning areas, and water management. According to [11], [12], and [13], the idea of a "smart campus" has become crucial for integrating technology into education. The study carried out plenty of investigation to review the latest achievements in the area of smart campuses, as well as smart cities more generally. According to the results, the framework was built with IoT and cloud computing as the primary supporting infrastructure which consists of eight major criteria and 25 sub-applications such as smart card, smart classroom, energy management, adaptive learning, smart vehicles, security & safety, optimization, and analytic data center and smart facilities services. According to the study, all of these criteria and sub-applications are based on IoT and cloud computing as the primary supporting infrastructure.

## **2.3 Methodology - scope**

This study aims to identify the essential criteria of smart campus dimensions and sketch a smart campus construction to build high-quality campus services with IoT technology, which makes each platform normalized and standardized.

## **3 Theoretical foundation: The smart campus proposed criteria and its applications**

Based on the review of existing works and some of what this study believes to be adequate for KAU to adopt and apply, this study summarizes the smart campus criteria and their applications that should be applied when sketching the KAU smart campus.

### **3.1 Smart community**

Transportation system (in and outside) trains between campuses all departments and services must be available, with public transportation available on campus, and created to be fully accessible for disabled people without architectural barriers. It effectively functions as a modern small city.

### **3.2 Smart library**

As the library is one of the most visited places in any university, the vision of the KAU smart library is to create an indoor living world to make students stay more connected with the library and where students and researchers can develop. According to [14], the Smart libraries concept is to serve all library services smartly, faster, and better, and to its end users through digital information technology through different software applications. [15] indicated that adopting smart technologies has bridged the gap between the services provided by libraries and the continuously evolving and competing needs of humans. Transforming traditional libraries to smart libraries by

strategic design requires the university to carry out advanced technologies, such as cloud computing, data mining, artificial intelligence, service building, and librarian training [16]. As KAU is one of the most important universities in Saudi Arabia, KAU's smart library may impact the libraries as cultural and scientific assets. Therefore, KAU smart library may play a critical role in involving the community and addressing its needs.

### 3.3 Disabilities services

students with a range of disabilities, such as those that are physically, visually, auditory, verbal, or mentally disabled, etc., need more attention to facilitate their access to all services.

Assistive technology items would improve the daily life of those with disabilities and make education more accessible. Some of the most important technologies that can help students with special needs include, but is not limited to, subtitling, dictation software, text-to-speech, automated magnifying lenses, sizable print keyboards, smart-Pens, and applications that transform soundtrack to braille all examples of assistive technology.

### 3.4 Smart maps

The emergence of digital maps because of technological advancement is gradually replacing outdated paper maps. The Smart map is interactive software that connects users to various objects in the visual environment, making it easier for users to understand the geographical environment and campus information, [17]. The interactive smart maps on campuses provide numerous services to users, such as positioning the user's exact location. Navigation technologies on the other hand help in determining the best route to reach a classroom, or other facilities like restaurants, ATMs, and transportation waiting stations. To implement this kind of map on large areas such as the university campus appropriate techniques must be provided, such as 3D maps, a mobile application that is linked to technologies such as GPS for outdoor maps, and Bluetooth beacons for indoor spaces. Smart maps also help enhance security and safety, as they contribute to identifying the main emergency exits, and assembly points, and in the event of disasters such as a fire, the maps can provide the users with alternative ways to exit a safe area. Also, locating ramps and elevators on these maps means an easier and better experience for disabled users. Finally, to guarantee a better user experience maps must be updated when changes are made.

### 3.5 Smart grid (Green campus)

- Lightening

one of the main requirements of a smart campus is lighting. This indicates using data in real-time to turn on or off, dim or brighten, or even change the color of interior and exterior lighting to save energy and increase security (CommScope Inc., n.d.)

- Solar System

Achieving sustainability through solar energy has become an increasingly accessible option [18]. With only six rainfall days and sunny weather all year round in Jeddah, the potential for solar energy is so high. Whereas solar energy is an inexhaustible renewable resource. It also benefits the educational institution, in terms of rationalizing electricity consumption, reducing the cost of bills, and contributing to the reduction of gases harmful emissions. As for maintenance, although installing solar panels on rooftops is so expensive, the panels are silent and contain no toxins, so they can be attached for as long as necessary, [19]. Adding

solar panels can be beneficial in various aspects of a smart campus such as water heating, heating, ventilation, lighting, and transportation.

- Water (drinking, recyclable...)

Water is an essential and effective element in all aspects of life. Providing clean water to students and employees is a high-priority service in universities. Several actions can be taken to ensure that sustainability is implemented on campus. Rationalizing water consumption is one of the most important aspects of a smart campus. Water used for ablution can also be recycled for irrigation and afforestation, saving water and increasing campus vegetation cover. Technologies such as The Internet-of-Things (IoT) can be applied to efficiently monitor water levels, detect leaks, and automatically refill tanks as needed.

- Smart Administration

Applications (Payments, registration, online classes, Podcasting messages, workshops, etc.,) to ensure a smooth educational process at the university, it is necessary to work on creating a smart application that contains many services targeting students, administrative, and faculty members. This application should be the first step in the student's university life, starting with completing the enrolment process, paying the financial dues, attending online lectures, and registering for workshops. The app can also broadcast emergency warning messages to all registered users. The application can also be linked to the previously mentioned smart maps.

- Smart learning

Interaction between learners, professors, and the environment is very crucial. Using information technologies and their applications (e.g., virtual reality, augmented reality, smart boards) would allow students to learn and enjoy what the information technology applications offer for them to be more interactive, increasing their productivity where students can engage rather than being only listeners.

Smart labs also play a great role in educational institutions. These smart labs make it possible for high-performance techniques to be used to conduct safe and effective world-class science (Romero et al., 2020).

Figure 1 shows the adaptable criteria from the existing literature [20, 21, 22, 23] and some of what this study believes to be adequate for KAU to adopt and apply. Based on the existing female campus map of KAU, this study applied the smart campus criteria and their applications that can be adopted and applied by KAU for better education.

Icons presented in Figure 2 and Figure 3 indicate what can be applied for KAU to shift the current campus to be smart. If this proposed transformation is taken into account, it would be the first step to shift from a traditional to a smart campus.

Figure 2 shows a summary of the main designated criteria for an adaptable E-campus that meet all user requirements to provide leading technologies that make it possible to create a sustainable smart campus in harmony with users' expectations (Faculty, students, business needs, the environment, etc.,) [23, 24, 25].

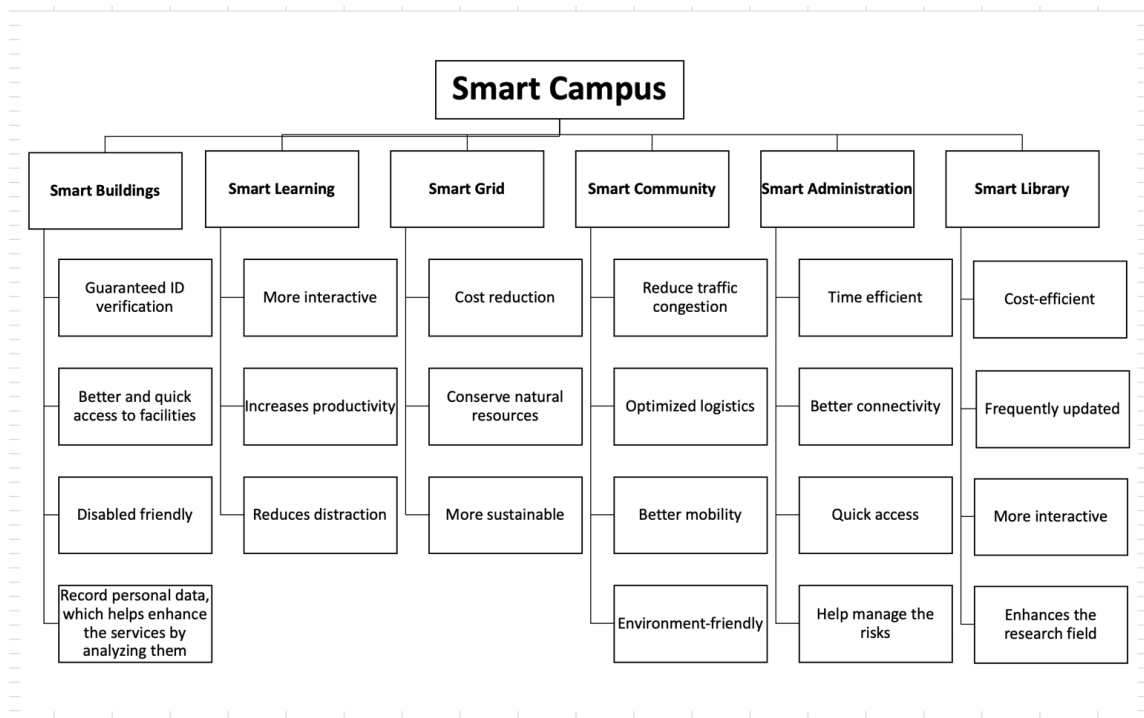


FIGURE 1. Integration of Services Under Smart Grid Infrastructure.







Application	Benefits
<p><b>Smart Buildings</b> E-cards, Smart maps, Disabilities services, etc.,</p> 	<p>Guaranteed ID verification</p> <p>Better and quick access to facilities</p> <p>Disabled friendly</p> <p>Record personal data, which helps enhance the services by analyzing them</p>
<p><b>Smart Learning</b> Smart labs, smart board, etc.,</p> 	<p>More interactive</p> <p>Increases productivity</p> <p>Reduces distraction</p>
<p><b>Smart Grid</b> Waste and water management, Solar system, lightening, etc.,</p> 	<p>Cost reduction</p> <p>Conserve natural resources</p> <p>More sustainable</p>
<p><b>Smart Community</b> Transportation system; trains, bicycles, scooters, buses, etc.,</p> 	<p>Reduce traffic congestion</p> <p>Optimized logistics</p> <p>Better mobility</p> <p>Environment-friendly</p>
<p><b>Smart Administration</b> Payments, registration, online classes, Podcasting messages, workshops, etc.,</p> 	<p>Time efficient</p> <p>Better connectivity</p> <p>Quick access</p> <p>Help manage the risks</p>
<p><b>Smart Library</b> Books drop, self-check-in, etc.,</p> 	<p>Cost-efficient</p> <p>Frequently updated</p> <p>More interactive</p> <p>Enhances research</p>

FIGURE 2. Adaptable Smart Campus Criteria.



FIGURE 3. KAU Smart Campus Sketch



## 4 KAU female smart campus proposed sketch

The following conceptual sketch is based on adaptable Smart Campus Criteria on the existing KAU female campus map. As this study used the actual existing map to sketch the potential changes that can be applied on a real campus (Figure 3)

Figure 3 shows the conceptual sketch for KAU female smart campus map. buildings are colored by categories. This study used 6 different colors to differentiate the buildings from each other. As shown in Figure 3, purple buildings represent the smart learning criterion, where some of the classrooms and labs are located. As shown in the proposed sketch, there are icons of the smart labs and smart boards. These are some of the applications and technology that can be implemented to enhance the interactive learning experience, they also increase productivity and reduce distractions for students.

Beige buildings represent the smart administration criterion. Administrative processes such as Payments, registration, online classes, Podcasting messages, and workshops are conducted in these buildings. Converting these processes into smart ones by technology guarantees quick access, and better connectivity, it is also time sufficient and helps manage the risks properly.

As for the tiffany colored buildings, they represent the smart library criterion. The main library on the campus is in building 14, but its services reach users in many different spots on the campus. For example, book drop robotic machines can be distributed on the campus for the users to return the borrowed books.

Smart buildings (blue), smart community (orange), and smart grid (green) are criteria that can be applied all over the campus. For example, solar panels are distributed above all buildings, scooter stops are located in many spots on the campus, and E-cards are used in educational, administrative, and facility buildings. In conclusion, it should be noted that some of the criteria are overlapping and can be applied to different kinds of buildings and some are specific to certain kinds of buildings and facilities, which appear in the distribution of icons on the map. For example, the smart map icon, which comes under the umbrella of the smart building criteria, is distributed on gates, classroom buildings, parking lots, and administrative buildings. Whereas the smart lab icon is exclusively used for the buildings that have labs.

## 5 Discussion

The smart campus proposed sketch provided in this study gives an idea of how simple the higher education landscape can be in the digital shift. Adopting all or some of the smart applications sketched in this study can benefit the female campus at King Abdulaziz University in delivering better education and better services for all its students, faculty, and staff. As part of our smart campus sketch, we focus on helping the female campus at KAU to provide students, faculty, and staff with technological advancements to cultivate the quality of student learning. We also proposed the implementation of technologies related to energy and the environment which supports sustainability on campus.

This study believes that if the proposed sketch is taken into account, it would be the first step to shift from a traditional to a smart campus.

## 6 Conclusion

To develop a sketch based on an old female campus map the study aimed to comprehensive understanding of the smart campus criteria proposed in this study. The purpose of sketching relevant

to the design ideation process was the possibility that King Abdulaziz University would adopt the sketch to provide better education services for both students and faculty members.

In conclusion, we are experiencing a digital culture that will enable us to transform almost every movement in our life to technological advancements. Therefore, this study aimed to sketch a smart campus for one of the oldest universities in Saudi Arabia's higher education community to achieve the Kingdom's 2030 vision of improving educational services for both students and faculty members.

## **7 Future research**

This study suggests that future research could, for instance, investigate the possibility to set united standard criteria for Saudi universities to follow when shifting to smart campuses. The application of one of the criteria mentioned above in table 1 on the female campus, in reality, can be an area for future research. More case studies in Saudi universities could also be an interesting topic for future work.

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