Budownictwo i Architektura 24(3) 2025, 31-46

DOI: 10.35784/bud-arch.7968
Received: 23.06.2025; Revised: 04.08.2025;
Accepted: 07.08.2025; Available online: 30.09.2025

Orginal Article

Smart transformation of cities: the case of the EMU Campus, North Cyprus

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Abstract: This research provides an overview of smart cities, their goals, and benefits, focusing on how smart campus projects serve as vital testbeds for larger urban transformations. The study ultimately focuses on the Eastern Mediterranean University (EMU) Campus in North Cyprus as its main subject of analysis. While urbanization continues to pose global challenges, requiring innovative planning solutions, this paper's primary aim is to explore the potential for smart campus development within a specific institutional and regional context. The framework of this overview study first delves into the literature on smart cities to identify their goals, aspects, components, and the role of Information Communication Technology (ICT) in achieving sustainability. It then reviews various smart campus projects, using a general overview to lead into a detailed case study of the Lille campus in Northern France. Building upon these insights, the paper subsequently explores the applicability of smart concepts to the EMU Campus, considering its unique local conditions and potential implementation constraints, which are further elaborated in the main body of the paper.

Keywords: Information Communications Technology (ICT); smart campuses; smart cities; sustainable cities

1. Introduction

As more and more people move to cities, properly planning for urban development is becoming increasingly important. It is estimated that by 2050, 70% of the world's population will live in cities. In this matter, Smart cities are a sustainable way to manage this rapid growth [1]. As urbanization accelerates, sustainability is becoming increasingly important. Smart cities are a potential solution as overall, smart cities have the potential to be sustainable, but more research is needed to determine their long-term impact. They may be unable to counteract the adverse effects of fast urbanization on our economy, society, and natural resources.

Numerous communities attempt to incorporate smart technologies into their infrastructure and structures [2]. This concept is seen to be feasible and successful, as evidenced by several attempts around the world. However, two main approaches exist to creating smart cities: from scratch and transforming existing cities. The first approach is exemplified by Eko-Atlantic City [3]. At the same time, the second is more common as most of the world's cities already exist, so transforming them into smart cities is more realistic than building new cities from scratch, such as cities like Chicago and Rio de Janeiro [4]. Transforming existing cities into smart structures is a complex process, and there is a lot to learn from successful initiatives worldwide [5]. This study will try to provide an overview of the most prevailing aspects of smart cities and their technologies, and fill in the gaps between what has been achieved and what is planned to contribute to the success of future smart city projects.

One of the challenges researchers face is the lack of scientific and key performance indicators to measure the feasibility and success of transforming existing cities into smart cities. This is especially true for a specific case study, such as changing the EMU campus into a smart city based on the experience of Lille University in France. Despite this limitation, this study introduces lessons learned from the methodologies used by Lille University. The researcher will collect data about the case and analyze their experiences using new technologies to transform their campus into a smart one, then identify the short-term and long-term benefits.

This overview article will explore how new technologies can transform urban development into smart cities. It will also propose a new framework for transforming the EMU campus into a smart city, based on the lessons learned from the Lille campus in France. The study will also include an overview of smart cities and campuses, some of their smart technologies, and their potential in creating sustainable developments. The authors use a qualitative research strategy, focusing on a case study of the Lille campus. Finally, results will be presented in a comparative and descriptive approach.

2. Theoretical background

2.1. Smart city concept

By increasing the efficiency of urban services, making the most use of available resources and infrastructure, and interacting with citizens through technology, smart cities use information and communication technologies (ICT) to enhance the quality of life for their residents [6]. Cities worldwide embrace smart city initiatives, with Hong Kong leading in this since 1998. Anyang City in Korea followed in 2003, recognizing the economic and social benefits of investing in technology and citizen participation. The most well-known examples are Chicago, which has been actively involved in smart city initiatives since 2011, Rio de Janeiro, which adopted smart technologies and data in an attempt to overcome the city's challenges in 2009, and Stockholm, which has been using ICT – smart technologies since 2007 to develop the city's services. Alongside Barcelona's well-known smart city movement in 2011, Boston City also worked on smart city initiatives that rely on smart technologies with community support. Furthermore, Tel Aviv, which is located in the Middle East, started implementing smart city initiatives in 2014 and took first place in the global competition for smart cities [7].

Nagpur emerged as the top smart city in India by 2016 [8], demonstrating the significant action taken by recent smart city programs in India, where over 100 cities are dedicated to becoming smart schemes. Since the majority of the literature on smart cities just outlines their objectives or strategies, there isn't a precise definition that has been agreed upon, however the following can be used as the definition: “A smart city is a municipality that uses information and communication technologies to increase operational efficiency, share information with the public, and improve both the quality of government services and citizen welfare.” [9].

While impactful, the concept of smart cities did not emerge overnight. We can argue that smart cities may be a development of earlier city plans that employed similar smart technologies, such as ubiquitous cities (U-City), digital cities, information cities, intelligent cities, and sustainable cities.

2.2. When smart cities began

Smart cities are new cities that use technology to connect and manage all of the city's systems, such as transportation, energy, and public services. They have their roots in digital cities, which started in the 1990s and continued into the 2000s, and focus on using the internet to explore cyberspace. On the other hand, today’s smart cities use sensors to explore the physical world around us. This is the next step in integrating our networked society with the physical world through cyber-physical systems. Similarly, Intelligent cities can be considered smart cities that use more advanced technology to automate tasks and react to human needs more intelligently [2,10].

Also, U-Cities are cities that use technology to connect all their services and infrastructure so anyone can access and use data from anywhere. These cities focus on sustainability, and they are considered to be smart cities [11]. This further raises the question of whether smart cities are sustainable advances.

To combat climate change and global warming, which are mostly brought on by an increase in unsustainable urbanization practices and unfair human activity, many cities worldwide are embracing sustainable alternatives. Because sustainable ways are pretty expensive, cities have been focusing on implementing smart concepts, which offer sustainability at a significantly lower cost [12]. However, if we claim that smart cities are sustainable, we must grasp their objectives to comprehend how they might contribute to social, economic, and environmental sustainability.

While the terms 'smart city' and 'sustainable city' are often used interchangeably, it is crucial to recognize their distinct yet complementary focuses. A smart city primarily leverages Information and Communication Technologies (ICT) to enhance efficiency, services, and connectivity. Conversely, a sustainable city is fundamentally concerned with environmental protection, social equity, and economic viability for long-term well-being, often with a reduced ecological footprint. As highlighted by [13], the political premises behind these concepts can differ, influencing their implementation strategies. Therefore, while smart technologies offer powerful tools to achieve sustainability goals – for instance, through optimized resource management or intelligent transportation systems – the mere adoption of technology does not automatically equate to a sustainable outcome. A sustainable smart city thoughtfully integrates technology to support comprehensive environmental, social, and economic objectives.

2.3. Smart city and sustainable city

Since smart cities consider sustainable development's economic, social, and environmental facets, they are closely associated with sustainability. Smart cities can improve sustainability's financial and ecological aspects and lessen environmental pressure by using natural resources. Furthermore, the social component of sustainability is supported by users' engagement and interaction with their surroundings in smart cities [6].

In general, a smart and sustainable city is an innovative city that uses new ICT-based technologies combined with various tools to improve living conditions and the effectiveness of urban services while upholding the demands of natural resources now and in the future. Smart and sustainable cities use new technologies to improve social and environmental health and well-being. They provide a safe, pleasant environment with high-quality services, create new job opportunities, and reduce inequality. One way of doing that is that smart cities use sensors to collect data about the city and then use that data to manage and organize the city more efficiently, helping to solve problems quickly and improve the overall quality of life. Moreover, the new technologies used in smart cities can be integrated into the planning process of urban developments at any scale. This helps make cities more efficient and sustainable, benefiting the urban communities [5].

2.4. Smart components for a city

Technology and connectivity are the main pillars of smart cities, and a city cannot be smart without the contribution of technology and connectivity [6]. Therefore, with the support of these primary attributes, a city can perform as a smart one; it can monitor and manage all of its different aspects, such as smart transportation, smart living, smart environment, smart economy, smart governance, and smart people [14]. Having these kinds of smart features is what makes a city smart.

To show how these smart features or components perform in a smart city, for instance, in the case of smart transportation, many smart cities operate a traffic system called the Intelligent Traffic System (ITS). In smart cities and metro systems, the ITS has the potential to profoundly alter how people move. ITS is a superior option since it provides different means of transportation, built infrastructure, traffic, and connection management solutions. It employs various electrical, wireless, and networking technologies to give clients a better, easier, and faster mode of transportation. It can monitor the traffic of roads, subways, railroads, and vehicles 24 hours a day, and then collects the information and sends it to a central control center, where the data is analyzed to provide a safe and pleasant traffic environment and optimum management of the traffic for free-flow traffic. Performance, convenience, and security are all factors that drive transportation technology advancements. Scientists and researchers in the transportation business collaborate to ensure that these breakthroughs bring more people (or products) to their destinations faster, safer, and with the fewest assets feasible. This is why, for example, coal-powered trains have been replaced with super bullet trains.

Another service a smart city provides is a smart living environment to offer safety and security to its citizens. This kind of service is possible with the help of an intelligent crime prevention system that is connected with the crime reporting center of the local police station. The system can recognize faces and license plates with the installed CCTVs spread throughout the city [7].

A smart environment feature in smart cities is available through the optimal management of natural resources such as water. With efficient water management, the maintenance process is much easier, as it can detect any water leakage with the help of installed smart sensors. It is also able to sense where the water supply has stopped, which can indicate an occurrence of an accident. A smart city can have a smart economy by saving energy through intelligent management. Real-time data on energy consumption of all types of buildings is monitored by smart IoT (Internet of Things) sensors that are fixed on those buildings [7]. The sensors also offer suggestions on what actions can be taken to reduce energy intake. Users can take those actions by using smart applications, where they turn off or on any device and manage the lighting, heating, and cooling of their houses with a touch on their smartphones from any place.

Smart governance, or E-government, is where a city's government services are mostly accessible online; this kind of feature eases the processes for the citizens and decreases the management costs [15].

Most importantly, for all these services to be valuable, the city must have smart people who know how to use such services; that is why many smart cities cases constantly provide programs that teach citizens how to make the most use of these services. A city becomes smart when it can deliver smartness in all aspects.

Finally, optimizing resource management and infrastructure, a critical dimension of smart cities – and by extension, smart campuses – lies in their capacity to enhance social capital and human interactions. Smart technologies can be instrumental in creating platforms that facilitate greater connectivity, collaboration, and collective intelligence among citizens or campus residents. For instance, the increase of human interactions in urban settings, often enabled by technological advancements, has been a central theme in urban studies, as explored in the seminal work by Luis Bettencourt and colleagues on scaling human interactions with city size [16]. Furthermore, developing technologies that ensure informed participation and foster shared knowledge is vital for truly inclusive smart environments. Michael Batty's work emphasizes how digital tools can empower citizens, creating more democratic and responsive urban systems [17]. Therefore, a holistic smart city or campus framework must consciously design for these social aspects, moving beyond mere efficiency to actively cultivate vibrant, interactive, and participatory communities.

2.5. Technologies of smart cities

Astute Incorporating intelligence into a city's transportation, urban mobility, safety, and energy supply systems makes it smarter. These services are provided by multi-layered technologies that require connectivity to function correctly because they cannot function independently [6].

Artificial Intelligence (AI), GIS, Augmented Reality (AR), smart sensors, and the Internet of Things (IoT) are some of the most popular cutting-edge technologies utilized in smart cities. Smart sensors are essential to a smart city since they react when the correct information is received. They are used in practically every function the city provides, such as security, where sensors are installed in windows and interiors and linked to alarm systems. Additionally, health issue sensors can detect smoke and harmful gases. Parking places can be controlled using sensors in transportation [5].

The connectivity of all electrical items, automobiles, electronics, sensors, software, and even some buildings within a network that establishes a platform for interaction and data exchange is known as the Internet of Things (IoT) [18]. The Geographic Information System (GIS) is utilized in mapping technologies for smart cities and places because it allows engineers and managers to transform data about a geographical location into operational information once it has been analyzed and visualized [1]. A digital overlay over real-world scenes that can be viewed on a smart device, augmented reality (AR) gives viewers information about the scanned scene, including landmarks, restaurants, buildings, and monuments [17].

2.6. Small-scale smart campuses and large-scale smart cities

Many universities have adopted smart city concepts and solutions to improve their campuses and make them more sustainable. University campuses are considered small cities, implying a good context for testing and implementing smart city approaches [19]. Many universities worldwide have utilized smart city solutions on their campuses, as using smart technologies has improved the experience for students and staff. To help us identify tactics and ways to make the Eastern Mediterranean University (EMU) campus in Northern Cyprus smart, this section of the study will examine some of the experiences of smart campuses, emphasizing the Lille campus in France.

Depending on the objectives and the technology being utilized, numerous approaches exist to make a campus smart. Energy conservation, maintenance automation, environmental preservation, parking efficiency, and attendance tracking are just a few of the efficient and successful ways to attain smartness. Furthermore, smart campuses often have smart maps to help people navigate and find their way around [20].

The University of Southampton, UK's experiment to transform a campus into a smart city was one of the first; it involved making data publicly available to improve campus user experience and possibly serve as a model for a successful smart campus program. However, using open data technology brought up several issues, including data privacy, security, and urban complications [20].

Another example is the University of Lagos in Nigeria, which was concerned with preventing financial theft and ensuring student security through web frameworks and a smart, unique identification system for each student. In the long run, this would fit into the cashless policy the Nigerian government was implementing throughout the city. Here, we can see how the experience of a cashless, secure smart campus served as a testbed for the big city smart plans, as the city was following the current global trend of cities using ICT in their financial sector [22].

To facilitate user guidance, smart campus schemes throughout the world are utilizing a variety of technologies, including indoor positioning (IP), marker-based cyber-physical interaction (CPI), and augmented reality (AR) to integrate cyber environment principles into their campus [23].

3. Study methodology

This study employed a qualitative research strategy using a descriptive and comparative case study approach. The Lille campus (SunRise project) in Northern France was selected as a primary case, serving as a benchmark for understanding smart campus implementation. Data collection was primarily through a comprehensive literature review, encompassing scholarly articles and project documentation related to smart cities and smart campuses, including a detailed analysis of Lille's experience.

Data analysis involved a comparative and descriptive approach. Information from the literature and the Lille case was synthesized to identify key characteristics and successful strategies. This comparative lens was then applied to assess the applicability of these concepts to the Eastern Mediterranean University (EMU) Campus, considering its specific context and challenges.

4. Discussion

4.1. Sunrise smart city project

The smart city of SunRise is located on the University of Lille campus, which is close to Lille city in the north of France (Fig. 1). The campus has about 25,000 inhabitants, the size of a small town. The campus has a total of 145 buildings, with various types of functions such as administration, student accommodations, entertainment activities, and research. The buildings function with a 100 km network supplying water, an electricity grid, rain drainage, street lighting, and a district heating system [1].

Fig. 1. SunRise smart city campus [1]

The Lille campus has implemented smart technology in three main areas, shown in Fig. 2: the water network, heating system, and electricity grid, as well as in the buildings themselves. The smart water network uses an Automatic Meter Reading (AMR) system to monitor water performance in real-time and detect abnormal consumption. This technology helps optimize system management by reducing consumption due to leaks.

The campus also plans to implement sensors to detect harmful chemicals or contaminants in the water. The electrical grid consists of two medium and high-voltage grids, which are monitored in real time by sensors that collect data on each building's current, frequency, voltage, transmission, and consumption. The main electricity supply enters the campus from the north and is distributed to various substations. If a fault occurs, the system will identify the nearest substation and isolate the affected area, helping to ensure the safety and security of the system and its users. The Lille campus is heated by a district heating system that consists of two primary and secondary networks that exchange heat through 37 substations [1].

These networks are monitored by smart sensors that collect data and transfer it to a central management center for analysis. Measurements include the consumption of each building and measuring water pressure, velocity, leakage, and temperature. The Lille campus uses data from its smart heating system to regulate the temperature of each building according to its type and performance, promoting energy savings. Moreover, the smart heating system also helps to manage energy consumption more effectively, prevent accidents and hazards, and ensure user safety [1,12].

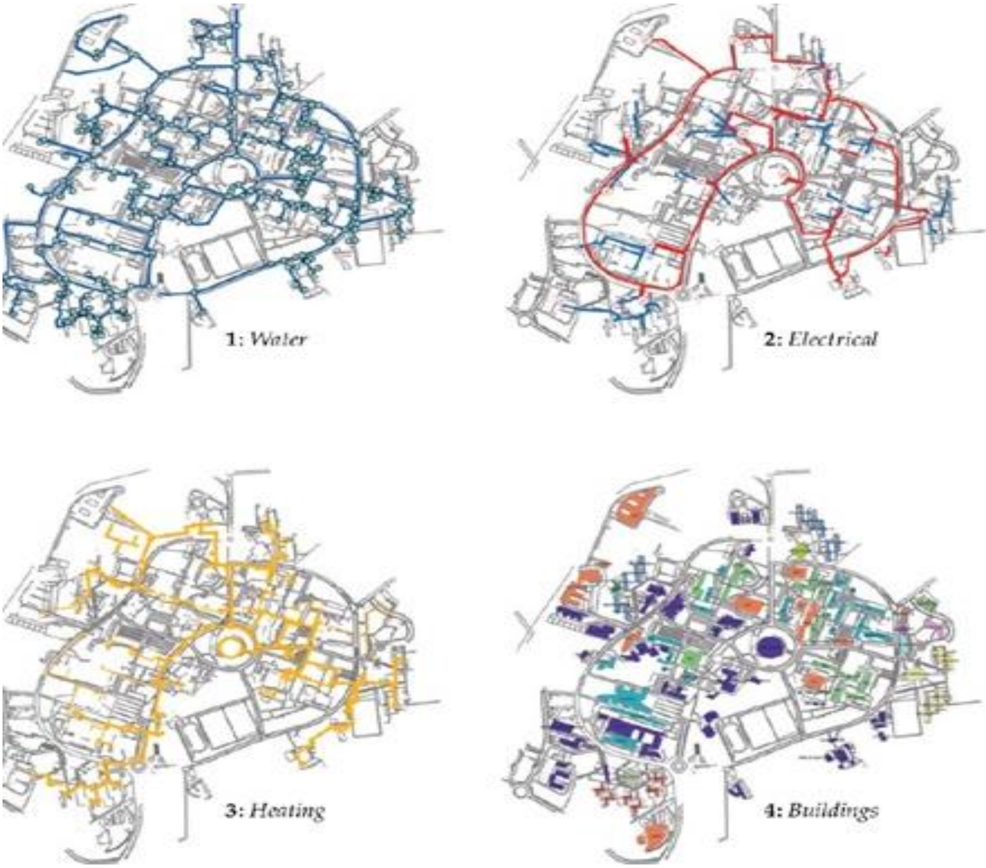

Fig. 2. The Lille camps smart networks [1]

In the conclusion, the SunRise smart city project at the Lille campus aimed to achieve sustainability through smart urban infrastructure, contributing to environmental health, economic advancement, and social well-being. Sunrise uses smart technologies such as sensors and GIS applications to monitor and manage its water network, electricity grid, heating network, and buildings, providing easy access to data collection, analysis, and response. Smart monitoring has led to efficient regulation of energy consumption, saving resources, and reducing costs. Additionally, the smart sensors have enabled automated maintenance, further reducing waste and saving money. To successfully transform a campus into a smart city, the Lille campus's SunRise smart city project required years of planning, study, research, and collaboration from the city government, university stakeholders, academic staff, and the Lille community.

4.2. Applying smart to EMU

4.2.1. EMU campus context and existing infrastructure

Eastern Mediterranean University (EMU) is a large public university in Northern Cyprus with a beautiful 3000-acre campus shown in Fig. 3. It is home to about 22,000 students and staff. The campus has everything students and staff need to live and learn, including administrative units, 11 faculties, 5 colleges, laboratories, activity halls, cultural centers, a library, a health center, sports facilities, dormitories, cafes, restaurants, supermarkets, a gym, ATMs, and other services. The campus also has many open spaces, including plazas and well-maintained landscaping [24,25].

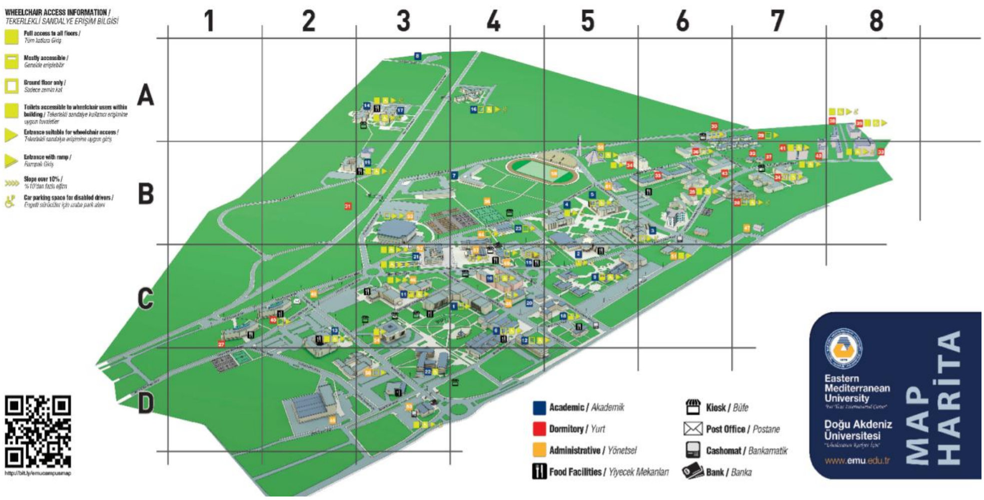

Fig. 3. Eastern Mediterranean University (EMU) Campus [24]

While detailed, publicly available infrastructure maps are a significant limitation for a comprehensive quantitative analysis, the Eastern Mediterranean University (EMU) campus presents a compelling case study for smart campus transformation within its unique context. Located in Famagusta, North Cyprus, EMU is a large public university serving a diverse international student body. Its physical layout encompasses various academic buildings, dormitories, recreational facilities, and administrative units spread across a defined area. The existing infrastructure, including its robust IT network, extensive Wi-Fi coverage across campus, and increasing reliance on digital learning platforms, already lays the foundational elements for smart integration.

Discussions with campus administration and observations indicate an ongoing, albeit incremental, adoption of smart technologies for security (e.g., CCTV systems), energy management in newer buildings, and digital communication platforms for students and staff. Future smart campus initiatives would build upon these existing digital backbones and physical spaces, aiming to optimize resource management, enhance learning environments, and improve overall campus life, albeit with considerations for the region's specific environmental and operational characteristics.

Beyond its physical and digital infrastructure, implementing advanced smart campus initiatives at EMU must also be understood within the unique geopolitical and legal framework of the Turkish Republic of Northern Cyprus (TRNC). As a de facto state, the

TRNC operates under specific political conditions that can influence international partnerships, technology transfer, and funding opportunities, often critical for large-scale smart city or campus projects. Legal frameworks about data governance, privacy, and global technological standards may also differ from those in internationally recognized states, potentially posing unique challenges or requiring localized adaptations for the deployment of 'smart' technologies. Acknowledging these distinct contextual factors is essential for developing a realistic and sustainable roadmap for EMU's smart campus transformation.

4.2.2: Proposed framework for EMU's smart campus transformation.

The vastly scaled EMU campus implies similarities to a small town; therefore, transforming the campus into a smart scheme would highly benefit the university and Famagusta City, as the EMU campus is the core of its public life, where many people rely on it for their livelihoods and social activities. So, any efforts to integrate smart solutions into the campus would be a step towards making the whole city a smart city. Smart cities have different components that share a few key features: a smart environment, smart mobility, smart living, smart people, smart governance, and smart economy. Therefore, to achieve smartness, smart cities must adopt advanced technology and connectivity [14]. Smart campuses aim to achieve smartness in several areas, including energy management, maintenance, security and safety, parking and driveway management, staff and student attendance tracking, and campus navigation [21].

The EMU campus faces some financial and technical limitations that could prevent it from achieving all of its smart campus goals in the short term. Financially, the university lacks the resources to fund such a large and complex project. At the same time, technically, the campus lacks complete network plans, making it difficult to implement smart technology across the entire campus. Despite these challenges, the EMU campus could still achieve short-term smart campus goals by working with the existing network plans.

The EMU campus only has two networks: an electricity grid and a water network. The lack of a heating network raises the question of whether it is feasible to create and integrate it with smart sensors, or whether it is better to focus on the existing networks. Smart projects are about using technology to save energy and resources. As such, it might not be worth building a new heating network when there are other ways to make the campus smarter and better, and focus on making the existing networks more efficient.

Planning for a smart campus transformation is a complex and long-term process that requires the collaboration of a wide range of stakeholders, including academics, IT staff, technical and engineering teams, university administrators, and the city government, where everyone has a unique role to play, working together to reach success. Such projects also require significant financial and technical support from all relevant parties.

The EMU campus is located between several major roads in Famagusta shown in Fig 4, and it is accessible to anyone 24/7, which raises security concerns, as anyone can enter the campus without authorization or identification. Applying smart security systems to the roads connecting the campus would improve security and safety for everyone, especially those living in the dormitories.

Many smart cities use Intelligent Traffic Systems (ITS) to monitor traffic and improve safety and efficiency. EMU could benefit from implementing an ITS on its campus and surrounding roads. Another smart city service that would be beneficial for EMU is an intelligent crime prevention system that could be connected to the local police station, use CCTVs to monitor the campus and surrounding roads, and help to keep track of who enters and leaves the campus, as well as to identify and respond to criminal activity quickly. EMU could also implement a smart parking system to help students and staff find parking spaces more easily and quickly, using a GPS to identify and notify users of available parking spaces. These smart city services would help make EMU a safer, more efficient, and more user-friendly campus (Fig. 5).

EMU could learn from Nigeria's experience, which used a college as a testbed for a cashless smart experience to reduce financial theft and create a smart identification system for each student. A smart identification system would help to improve security for everyone on campus, especially international students. It would also help to track student attendance and staff commitment to their duties.

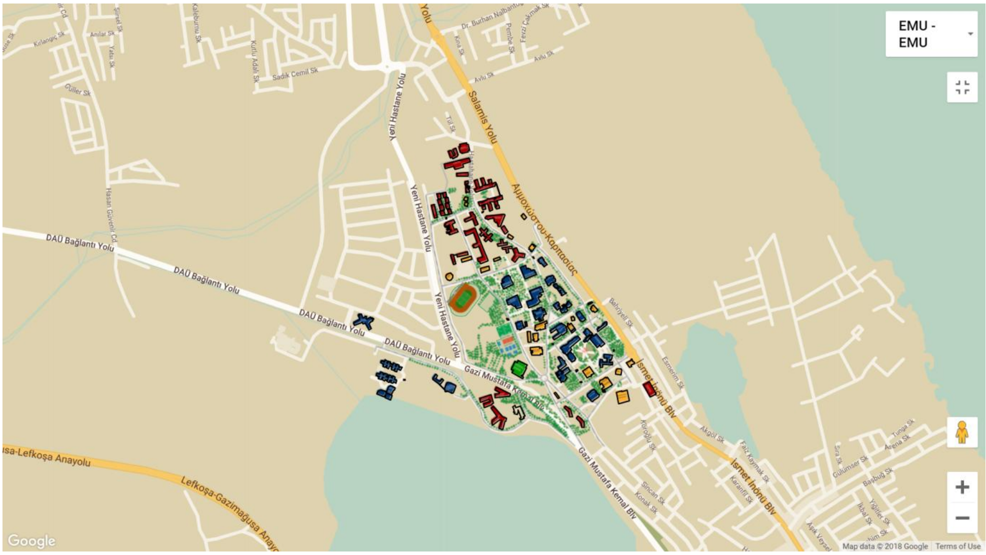

Fig. 4. EMU Campus – accessibility [23]

Fig. 5. EMU Campus – interactive map – note that when choosing a place on the map, it zooms in and provides an image of that place. Moreover, dragging the little human figure to any place on the map would give a view of it. Anyone, anywhere, can identify their location using this application [25]

EMU already has a smart interactive map on its public website, which helps users find their way around the campus, which is an essential motivation for smart campus projects. From this perspective, EMU has already been found to have a smart interactive map; it can be enhanced with augmented reality (AR). AR would make the map more interactive and easier to use and help students, staff, and visitors find their way around the campus. Adding AR to the map would take EMU's smart mapping system to the next level and make the campus more cyber-physical. This is an interesting component of smart city projects and would help to make EMU a more user-friendly campus for everyone.

Connecting all data throughout the university servers through big data applications and the IoT would make it easier for anyone, anytime to access the campus, this could be of some concern because and as mentioned before such a goal faces some privacy of data concerns, however, if specific data were to be available through the IoT and the big data smart application technologies it would bring great benefit to students and staff searching for information through the internet, trying to access the library off-campus or at any point of the campus, teachers preparing the lecture hall before lectures remotely which would save time and effort during class hours, same goes to students having a class presentation, assistants would be able to lock and unlock class halls, computers, data shows, through smart applications of the IoT – Whatever is connected.

The examples might be vast and random, but they all lie under the same goal: energy efficiency. After all, wouldn't life be so much easier if everything were connected to the internet? Wouldn't you feel much better if the air conditioner were turned on in your office, for instance, to be heated or cooled down before you reached it? With IoT in smart campuses and with smart applications, this couldn't be achieved in the short term. As for the long-term goals, and after running a background check on the technical resources of EMU, integrating smart sensors into the electricity, water, and heating network might be hard to achieve with the limitations mentioned earlier. Thu some procedures could be taken into place, such as integrating the buildings themselves with smart sensors that would connect directly to the GIS system – that should be created – to collect data about each building, these data will help bring an understanding to how efficiently each building is consuming electricity for instance which would help in the process of saving energy where needed. It would also detect energy faults and allow maintenance to be automated promptly.

The same goes for the water network, as the overall grid is non-existent, yet we can apply smart sensors to specific existing locations on-site; this might not help achieve smart monitoring, but it may help detect leakage or contamination. Of course, this would be a temporary suggestion until the technical team at EMU comprehends fully detailed urban infrastructure maps, which would help develop a smart energy-efficient environment at EMU. As for the heating network, which is a non-existent network in the EMU campus, working with the already existing networks might be more sustainable.

More suggestions for making EMU smart might include the university's transportation system. This system would develop a smart application that connects the buses on the IoT, and all users could track the bus by its lane or number. This way, the system will work more efficiently for users and the bus management. Would you like to miss a bus again? This might sound ironic, but if well-developed, smart transportation is one of the best ways to save time, effort, and energy.

5. Conclusion

Through technology and connection, smart city initiatives aim to improve urban residents' quality of life sustainably. Smart city initiatives are developed to determine the most effective way to integrate the key components of sustainability (social, environmental, and economic) to create a better way of life. Information and communication technology, or ICT, has been a powerful and long-lasting force behind the creation of these initiatives. Such large-scale projects are thought to be tested on smart campuses.

Nonetheless, many smart cities' goals and incentives may differ from those of smart campuses. This study will highlight the disparities, and by compiling and evaluating those differences, we will arrive at the result in Table 1. By analyzing each reason, we may determine that they all somehow relate to one another, even though they may exhibit some disparities.

Table 1. Smart city goals – Smart campus goals. (Authors)

Smart city goals	Smart campus goals
Smart environment	Smart resource management
	Smart people
Smart mobility	Smart parking and mobility
Smart living	Safety and Security
Smart people	Smart tracking of staff and student attendance
Smart governance	Smart map and guidance systems
Smart Economy	Automate maintenance

Table 2 shows detailed smart campus motivations divided into long-term and short-term goals. This comes as a conclusion to the several cases, methodologies, and lessons learned from previous smart campus projects worldwide. If well comprehended, these goals can be the starting point for achieving a plan to transform EMU's campus into a smart city project.

Table 2. Smart campus motivations to be applied at EMU. (Authors)

Motivation	Short term	Long term	Existing
Smart energy management systems		✓	
Automate maintenance		✓	
Safety and Security	✓		
Smart parking and mobility	✓		
Smart tracking of staff and student attendance	✓		
Smart map and guidance systems			Needs further development

6. Further research

Further research is always needed at all stages of developing and implementing the transformation plan for EMU's campus to become smart, as smart city projects are a new emerging trend and are being developed rapidly worldwide, smart technologies. Smart applications are wide and designed to withstand these projects; each project may use different technologies to achieve its goals. Still, it's essential to be up to date with all the technologies and applications available to comprehend a solid plan that uses the best technologies and applications to achieve the goals of this project in the best ways possible, smartly, efficiently, and sustainably. For instance, further studies into incorporating advanced object monitoring using wireless sensor networks throughout university campuses [26] might be an approach worth tackling for time-effective and efficient smart transformation.

Acknowledgments

The author would sincerely acknowledge their Institution, the private university of Jerash, for their support.

Funding

This work did not receive any funds.

References

[1] Afaneh A., Shahrour I., "Use of GIS for the SunRise Smart City project, a large-scale smart city demonstrator," in *Sensors, Networks, Smart and Emerging Technologies*, 2017. https://doi.org/10.1109/SENSET.2017.8125071

[2] Afaneh A., Alshafei I., "The influence of smart technologies: A comparative study on developing large to small scale smart cities and smart campuses," in *IOP Conference Series: Earth and Environmental Science*, 1210(1), (2023), 012015. https://doi.org/10.1088/1755-1315/1210/1/012015

[3] Bosch P., Jongeneel S., Rovers V., Neumann H., Airaksinen M., Huovila A., "CITYkeys indicators for smart city projects and smart cities," *CITYkeys Project Report*, 2017. Available: https://www.citykeys-project.eu/wp-content/uploads/2017/03/CITYkeys-D1.4-Indicators-for-Smart-City-projects-and-smart-cities.pdf [Accessed: 20 Nov 2020]

[4] Afaneh A., "Urban planning and culture: Recommendations for smart city planning," in *Smart City: French-Dutch Young Talents Meeting*, Paris, France, p. 7, 2014. Available: https://www.slideshare.net/FNEH/scientific-article-recommandations-for-smart-city-urban-planning-culture [Accessed: 20 Dec 2019]

[5] Bouskela M., Casseb M., Bassi S., De Luca C., Facchina M., *The Road toward Smart Cities: Migrating from Traditional City Management to the Smart City*. Washington, DC: Inter-American Development Bank, 2016. https://doi.org/10.18235/0012831

[6] Lee T., "Are smart cities sustainable? Toward the integration of the sustainable and smart city," *Journal of Environmental Policy and Administration*, 25(S), (2017), 129–151. https://doi.org/10.15301/jepa.2017.25.S.129

[7] Lee S., Kwon H., Cho H., Kim J., Lee D., *International Case Studies of Smart Cities: Songdo, Republic of Korea*. Inter-American Development Bank and Korea Research Institute for Human Settlements, 2016. Available: https://publications.iadb.org/en/international-case-studies-of-smart-cities-songdo-republic-of-korea [Accessed: 20 Nov 2020]

[8] Kandpal V., "A case study on smart city projects in India: An analysis of Nagpur, Allahabad and Dehradun," in *Companion Proc. of the Web Conf. 2018 (WWW '18)*, Lyon, France, Apr. 2018, pp. 927–932. https://doi.org/10.1145/3184558.3191522

[9] Shutters S., "Urban science: Putting the 'smart' in smart cities," *Urban Science*, 2(4), (2018), 94. http://doi.org/10.3390/urbansci2040094

[10] Ishida T., "Digital city, smart city and beyond," in *Proc. 26th International Conference World Wide Web Companion (WWW '17 Companion)*, Perth, Australia, Apr. 2017, pp. 1151–1153. http://doi.org/10.1145/3041021.3053050

[11] Cavada M., Hunt D., Rogers C., *The little book of smart cities*, Lancaster, UK: ImaginationLancaster, 2017. Available: https://research.birmingham.ac.uk/en/publications/the-little-book-of-smart-cities [Accessed: 28 Dec 2018]

[12] Schumann L., Stock W. G., "Acceptance and use of ubiquitous cities' information services," *Information Services and Use*, 35(3), (2015), 191–206, 2015. http://doi.org/10.3233/ISU-140759

[13] Hatuka T., Rosen-Zvi I., Birnhack M., Toch E., Zur H., "The political premises of contemporary urban concepts: The global city, the sustainable city, the resilient city, the creative city, and the smart city," *Planning Theory & Practice*, 19(2), (2018), 160–179, 2018. http://doi.org/10.1080/14649357.2018.1455212

[14] Shahrour I., *et al.*, "Lessons from a large scale demonstrator of the smart and sustainable city," in *Sustainable Mobility in Smart Metropolis*, Springer, 2017, 193–206. https://doi.org/10.1007/978-3-319-49899-7_11

[15] Sadiku M. N. O., Shadare A. E., Dada E., Musa S. M., "Smart cities," *International Journal of Scientific Engineering and Applied Science (IJSEAS)*, 2(10), (2016), 1–5. Available: https://www.academia.edu/30952551/Smart_Cities [Accessed: 21 Oct 2019]

[16] Schläpfer M., *et al.*, "The scaling of human interactions with city size," *J. R. Soc. Interface*, vol. 11, no. 98, p. 20130789, 2014. http://doi.org/10.1098/rsif.2013.0789

[17] Batty M., Axhausen K. W., Giannotti F., Pozdnoukhov A., Bazzani A., Wachowicz M., Ouzounis G., Portugali Y., "Smart cities of the future," *The European Physical Journal Special Topics*, 214(1), (2012), 481–518. https://doi.org/10.1140/epjst/e2012-01703-3

[18] Buscher V., Doody L., *Global innovators: international case studies on smart cities*. London, U.K.: Dept. for Business Innovation and Skills, 2013. Available: https://www.gov.uk/government/publications/smart-cities-international-case-studies-global-innovators [Accessed: 28 Dec 2019]

[19] Saha H. N., *et al.*, "IoT solutions for smart cities," in 2017 8th Annual Industrial Automation and Electromechanical Engineering Conference (IEMECON)*, 2017, 197–202. Available: https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&q=Saha+H.%2C+et+al.%2C+%E2%80%9CIoT+solutions+for+smart+cities&btnG=

[20] Amato G., Cardillo F., Falchi F., "Technologies for visual localization and augmented reality in smart cities," in *Sensing the Past: From Artifact to Historical Site*, Springer, 2017, pp. 419–434. https://doi.org/10.1007/978-3-319-50518-3_20

[21] Vasileva R., Rodrigues L., Hughes N., Greenhalgh C., Goulden M., Tennison J., "What smart campuses can teach us about smart cities: User experiences and open data," *Information*, 9(10), (2018), 251. http://doi.org/10.3390/info9100251

[22] Abuarqoub A., Abusaimeh H., Hammoudeh M., Uliyan D., Abu-Hashem M. A., Murad S., Al-Jarrah M., Al-Fayez F., "A survey on internet of things enabled smart campus applications," in *ICFNDS '17: Proceedings of the International Conference on Future Networks and Distributed Systems (ICFNDS)*, Cambridge, U.K., 2017, 1–7. http://doi.org/10.1145/3102304.3109810

[23] Adetiba O., Ota T., Omoraiyewa J., Owolabi F., "e-Paycheque framework with contact electronic card and fingerprint biometric for cashless smart campuses," in *Proceedings of the International Conference on Science, Technology, Education, Arts, Management and Social Sciences*, 2014, 445–452. Available: https://www.academia.edu/7255331/E_PAYCHEQ [Accessed: 19 Dec 2019]

[24] Subakti H., Jiang J., "A marker-based cyber-physical augmented-reality indoor guidance system for smart campuses," in *Proc. 2016 IEEE 18th International Conference on High Performance Computing and Communications; IEEE 14th International Conference on Smart City; IEEE 2nd International Conference on Data Science and Systems*

(HPCC/SmartCity/DSS), Sydney, Australia, 2016, 1276–1281. http://doi.org/10.1109/HPCC-SmartCity-DSS.2016.0182

[25] Eastern Mediterranean University, "About EMU," 2018. Available: https://www.emu.edu.tr/north-cyprus-universities [Accessed: 28 Dec 2018]

[26] Al Rawajbeh M., Haboush A., "Advanced object monitoring using wireless sensors network," *Procedia Computer Science*, 65, (2015), 17–24. http://doi.org/10.1016/j.procs.2015.09.006