

Editorial Corner

Advancing Sustainable University Technoparks through Smart Infrastructure and Green Campus Development: A Review of SDG-Oriented Strategies

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Universities have long been recognized as centers of knowledge creation and talent development. However, in the twenty-first century, their role extends far beyond education and research. Universities are increasingly expected to contribute directly to economic growth, technological advancement, environmental sustainability, and societal well-being. In this context, university technoparks have emerged as powerful innovation ecosystems that bridge academia, industry, government, and society.

Initially established to facilitate research commercialization and technology transfer, university technoparks have evolved into dynamic platforms that nurture entrepreneurship, support startup development, and accelerate innovation. Today, they are becoming strategic instruments for achieving sustainable development by integrating smart infrastructure, green campus initiatives, and sustainable technologies within academic environments.

The rapid advancement of digital technologies has transformed the traditional university campus into a smart campus. Smart infrastructure enables universities to manage resources more efficiently through the use of artificial intelligence (AI), Internet of Things (IoT) technologies, data analytics, and automation systems. Smart energy networks optimize energy consumption, while digital monitoring systems improve operational efficiency and reduce environmental impacts. Smart mobility solutions, including electric transportation, intelligent traffic management, and pedestrian-friendly designs, further contribute to sustainable campus operations.

Beyond digital transformation, green campus development has become a defining feature of modern university technoparks. Sustainable buildings, renewable energy integration, efficient water management systems, and waste reduction

initiatives are increasingly being adopted to create environmentally responsible campuses. Green spaces, biodiversity conservation programs, and ecosystem restoration projects not only improve environmental quality but also provide valuable opportunities for education, research, and community engagement.

The growing emphasis on sustainability has positioned university technoparks as living laboratories where innovative solutions can be developed, tested, and demonstrated in real-world settings. These environments allow researchers, students, entrepreneurs, and industry partners to collaborate on practical challenges while generating measurable environmental and social benefits.

The United Nations Sustainable Development Goals (SDGs) provide an important framework for guiding these efforts. Sustainable university technoparks contribute directly to several SDGs, particularly SDG 4 (Quality Education), SDG 7 (Affordable and Clean Energy), SDG 9 (Industry, Innovation and Infrastructure), SDG 11 (Sustainable Cities and Communities), SDG 12 (Responsible Consumption and Production), SDG 13 (Climate Action), and SDG 17 (Partnerships for the Goals). Through research, innovation, education, and stakeholder engagement, technoparks create pathways for translating global sustainability ambitions into practical actions and measurable outcomes.

A key factor behind the success of university technoparks is their ability to foster collaboration. The evolution from the Triple Helix model, involving universities, industry, and government, to the Quadruple Helix model, which incorporates civil society, highlights the growing importance of inclusive innovation. Sustainable solutions are most effective when developed through partnerships that engage multiple stakeholder and reflect diverse perspectives. Such collaborative

ecosystems strengthen innovation capacity while ensuring that technological advancements address real societal needs.

Across the world, successful university technoparks demonstrate the transformative potential of these ecosystems. Many have established strong partnerships with industry, developed advanced research facilities, promoted entrepreneurship, and implemented sustainability-focused initiatives that contribute to regional and national development. These examples illustrate how universities can serve as engines of innovation while simultaneously addressing environmental and social challenges.

As universities navigate the challenges of sustainability, digital transformation, and global competitiveness, university technoparks are emerging as vital catalysts for innovation and societal progress. At KMUTNB Techno Park (Figure 1), we embrace a vision that extends beyond technology transfer and research commercialization. We aspire to create a dynamic innovation ecosystem where academia, industry, government, and communities collaborate to develop sustainable solutions for the future. Through our focus on advanced manufacturing, sustainable materials, renewable energy, digital technologies, and entrepreneurship, we seek to transform knowledge into meaningful impact. By aligning our initiatives with the Sustainable Development Goals (SDGs), KMUTNB Techno Park is committed to fostering innovation that supports economic growth, environmental responsibility, and social well-being. We believe that university technoparks can serve as living laboratories for sustainable development, empowering future generations to build a smarter, greener, and more resilient world.

Despite these achievements, challenges remain. Sustainable infrastructure projects often require substantial investment, while fragmented governance structures and policy limitations may hinder implementation. Technology adoption barriers, including financial constraints, skills shortages, organizational resistance, and cybersecurity concerns, can also slow progress. Furthermore, achieving carbon neutrality requires long-term commitment, strategic planning, and continuous innovation.

Fortunately, these challenges also create opportunities. Artificial intelligence, digital twins, predictive analytics, and advanced IoT systems offer unprecedented capabilities for campus management

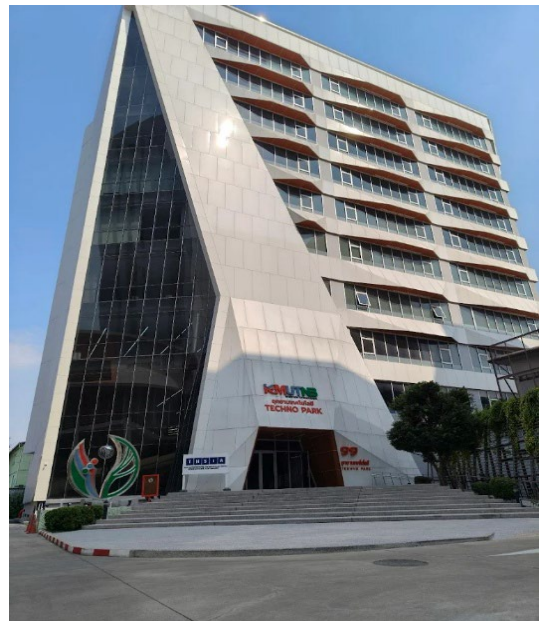


Figure 1: KMUTNB Techno Park.

and sustainability monitoring. Renewable energy technologies continue to become more efficient and affordable, while circular economy principles provide pathways for minimizing waste and maximizing resource utilization. As universities strengthen partnerships with industry and government, the potential for scaling sustainable innovations will continue to grow.

Looking ahead, future research should focus on integrated frameworks that combine smart infrastructure, green campus development, sustainable materials, and SDG implementation. Standardized sustainability indicators and performance metrics are needed to assess the long-term environmental, economic, and social impacts of university technoparks. Comparative international studies can further identify best practices, governance models, and policy strategies that support successful implementation.

Sustainable university technoparks represent more than physical spaces for innovation. They are strategic platforms that shape the future of higher education, industry collaboration, and sustainable development. By combining technology, sustainability, and partnership-driven innovation, these ecosystems have the potential to become global models for addressing the complex challenges of the twenty-first century and creating a more resilient, inclusive, and sustainable future.



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