UBT "SMART City" Model as a Testbed for Emerging Digital Technologies and Transformative Urban Planning

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Abstract
Humankind is currently living in a hyper-dynamic and constant transforming environment- in the so-called convergence era and 4th industrial revolution. This level of development requires a complexity-led approach and transformations of our political, societal, economic and technological framework: the way we are living and being educated, creating new jobs and generating sustainable growth, providing security, managing hyper mobility, as well as other development aspects related with our living quality and human values. This paper elaborates a specific model named UBT "SMART City" (Small Scale Smart Sustain System) which represents a concept of Entrepreneurial Innovation Ecosystem which could also be used as a Test-Bed for Future and Innovative Urban Planning with a particular focus in education, future planning concepts and emerging technologies.

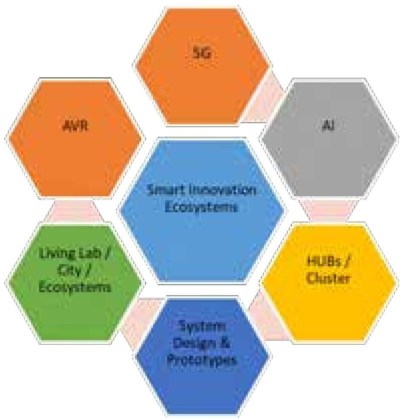
Keywords: *Smart Cities; Emerging Technologies; Transformative Urban Planning; Sustainable Development; Innovation Ecosystem*

Introduction and Background

The fourth industrial revolution is characterized by numerous emerging and disruptive technologies while technology is reshaping business practices, leading to improved market opportunities that also demand education and skills for innovation. AI, for instance, is currently used to fill a growing number of professional positions, and thus, the gig economy is booming. Ajah et al (2019) emphasizes that exponentially growing fourth revolution is characterized by the convergence of technologies that eradicate traditional boundaries across the physical, digital, and biological realms. Despite the fact that there are numerous opinions regarding the actual dates of beginning of the Fourth Industrial Revolution ((Ciulli, 2019) it is widely accepted that the term "Industrie 4.0" was firstly introduced at the Hannover Fair in Germany in 2011, and from this, the term "Industry 4.0" was derived, and it represents the Fourth Industrial Revolution. While the fourth industrial revolution (4IR) is gradually gaining momentum in a wide range- and as it gathers pace, innovations are becoming faster- many believe that the technologies that have been developed recently will allow organizations to enter a new computerized era to manufacture and manage large systems that were too complex to be integrated, monitored, and controlled before the advent of Industry 4.0 (Krajewski et al, 2022)....". On the other hand; since its beginnings UBT has always followed the current technological and socio-economic trends and developments, while in certain situations it has taken the leading roal towards future oriented solutions and forward-looking initiatives. In these terms, UBT now bases its scientific, research, teaching and innovation activities on the UNIVERSITY 4.0 Concept, by integrating Fully Digitalized Research and Education Process, CLASSROOM 3.0, Augmented and Virtual Reality (AVR) and 5G Telecommunication Network in its main Innovative and Scientific Campus in Lipjan/Kosovo and its other campuses and premises around Kosovo. The campus has been designed and developed around the small-scale smart city concept by covering all fields of life occurring in an open campus.

Driven by current technological development, innovative initiatives and its forward-looking vision, UBT has achieved a fully digitalized education and research process, mainly based on Augmented and Virtual Reality (AVR) technology offered by EON REALITY platform. In this regard, our institution has been recently implementing 2 important projects in Virtual and Augmented Reality technology. This platform allows all faculties (both students and staff) to contribute to the simplifying and enriching everyday life in terms of research and study.

UBT Model for Smart Ecosystem University can be illustrated as below:



This model fully integrates the Smart Systems, Resilience and Sustainability also the Society 5.0. Thus, we consider it one of the first small scales Systems Design globally.

In addition to previous initiatives, projects and innovations, UBT has recently established two institutes and laboratories in the fields of Artificial Intelligence and Cyber Security (CERT). This is in line with our strategic orientation and commitment to create and maintain a creative and innovative ecosystem which is based on integrative and transdisciplinary approaches in line with Convergence Revolution. This ecosystem should deliver all required resources to help others to fully realize one's potential- based on belief that human potential is unlimited. An important part on the digital transformation is as well the cyber security issues in the technological infrastructure. Thus, UBT has established the necessary tools, techniques and standards through which we ensure that all the assets including logical and physical are well protected and in compliance with industry standards. In these terms, UBT will focus their cyber crisis management on two main parts, namely Readiness and Response and these are detailly described below.

As per Augmented and Virtual Reality Platform; UBT has been recently implementing 2 milestone projects in Virtual and Augmented Reality technology (Prishtina, XK - EON Reality). This platform allows all faculties (both students and staff) to contribute to the simplifying and enriching everyday life in terms of research and study. Currently, the platform has over 1.8 million 3D, 2D and 360 Degree assets, while up to 40 thausands new assets are being created and added to the platform in each semester. Consequently, the implementation strategy for AVR and the connection of education with the industry occurs as following:

Each faculty contributes to the advancement of ICT in the industry using VR and AR industrial projects. *The Faculty of Management, Business and Economy (MBE), for instance, uses* the assets of this platform to change and transform the Marketing sector in the industry, creating assets for companies to promote their values using virtual interactivity. *The Faculty of Architecture and Spatial Planning* deals with the promotion of Tourism and historical values by turning this industry into VR and AR by digitizing the whole process of tourism promotion and virtual visits in historical sites and monuments. *The Faculty of Mechatronics* helps the manufacturing industry and all robotics industries to animate the work process for employees and management staff so that they can animate any process before starting the investment and as such it ensures time and cost efficiency in each company. *The Faculty of Design* uses VR and AR to help fields like Medicine, Manufacturing Industry, Marketing, Transport etc. on designing different tools and assets for their needs and purposes. *The Faculty of Computer Sciences* uses the VR and AR platform for enabling the creation of interactive games for education as well as enabling the heath education in the field of medicine.

As per 5G Technology, 5G Hub and Test-bed; among many innovative and future based projects UBT has launched its 5G Hub which will be used for domestic needs (research, testing, experimentation) and also will help the industry to test their products and test them in a technology of the future as there is still no such network in Kosovo.

As per fully digitalization; driven by current technological development, innovative innitiatives and its forward-looking vision, UBT has achieved a fully digitalized education and research process, mainly based on Augmented and Virtual Reality (AVR) technology offered by EON REALITY platform and other supportive tools. The new digital forms enable students to access lectures 24/7 giving them the opportunity to study according to the schedule that was adjusted. Also through digital platforms students will have the opportunity to access new technologies through which they will receive faster information about national and global scientific developments in various scientific fields. The use of digital transformation will have a singular impact in improved accessibility and access, personalized learning approaches, access to Augmented Reality & Virtual Reality, Cloud-based learning opportunities, Incorporating the Internet of Things into the school environment, Security across digital devices, Big Data etc. Additionally to other initiatives and innovations that are presented previously, UBT has established two institutes and laboratories in the fields of Artificial Intelligence and Cyber Security System, which lays on Institution's CERT (Computer Emergency Response Team). Furtherly, UBT has recently established UBT VR/AVR Hub, UBT Knowledge Hub, as well as Sports, E-Sport & Art Hub. All of these developments and concrete actions are in line with Institution's strategic orientation and commitment to create and maintain a creative and innovative ecosystem which is based on integrative and transdisciplinary approaches in line with Convergence Revolution. This ecosystem should deliver all required resources to help others to fully realize one's potential- based on belief that human potential is unlimited, and thus is also in line with Institution's commitment to implement the 4th Industrialization advancements continually and with consistency.

Artificial Intelligence (AI) and Cyber Security System (CERT)
Both the institute and center aim to contribute to society as well as help the government, the army, the police and many other stakeholders. The institute that carries with it the laboratory of artificial intelligence with a data center with a supercomputer will be able to help many fields and faculties abroad, as described below:

The Faculty of Management, Business and Economy (MBE) will use the possibility of supercomputers for Business to enable banks and institutions to increase the quality of services by making predictions for the future thanks to artificial intelligence and supercomputers with their data. Also, the institute for security will enable all government institutions to increase the cyber security capacities of this institute and also to do the necessary tests in the CERT laboratory. *The Faculty of Architecture and Spatial Planning* will be supported through artificial intelligence to create the possibility for drones to take 3D images in real time and process those images for various purposes in the industry of virtual reality design, animations, etc. *The Faculty of Mechatronics* will use artificial intelligence in many fields and the testing of production machines in our laboratories, also supercomputers are used for testing algorithms for the image process in intelligent drones, and many new industries that use AI etc. *The Faculty of Computer Sciences* may use supercomputers for testing algorithms in various fields in medicine, the automotive industry, and all fields related to artificial intelligence. *The Faculty of Agriculture will* use supercomputers and artificial intelligence to calculate changes in drone scanning of the fertile area and the possibility for scientific research in the field of agriculture.

When it is combined with previously promoted initiatives and innovations, as such as UNIVERSITY 4.0 Concept, Fully Digitalized Research and Education Process, CLASSROOM 3.0, Augmented and Virtual Reality (AVR) and 5G Telecommunication Network, it will let our institution to further develop its research infrastructure in order to get research and its outputs more easy, fast, effective and more visible.

UBT VR/AVR Hub

Even though VR and AR are still largely in the developmental stage, these concepts are no longer science fiction. Considering the pace of the technological development, as well as consumer and industry demands, researchers have put an emphasis on producing technology through which we solve problems and interact with our world. From UBT's point of view, hosting the EON-XR Cluster Center and bringing EON-XR to campus comes with the opportunity to distinguish even further. By utilizing the interconnected self-service platform and the **Classroom 3.0 Model**, the world-class school is able to improve the interactivity and retention in lessons while also preparing students for the future by teaching them the technology that many leading industries and businesses are already using.

UBT Sports, E-Sport & Art Hub

UBT Sports, E-Sport & Art Hub is the newest center for the development of young talents in the field of sports and movement sciences. Through this center, young people have the opportunity to gain new knowledge in the field of sports and movement sciences, from the expertise of professional staff and to further develop their sports skills and talents. Among others, it integrates digital tools, software, and advanced technologies and application to help smart sport health managements, performance measurement and tracking, as well as managing the healthy nutrition processes.

Readiness and Response

UBT has established the necessary tools, techniques and standards through which we ensure that all the assets including logical and physical are well protected and in compliance with industry standards. In these terms, UBT will focus their cyber crisis management on two main parts, namely Readiness and Response, Readiness equates not only to vigilance, for example in the form of 24/7 Monitoring, but also to readiness of resources. A well prepared, multifunctional team will be poised to deal with all aspects of an incident or crisis. In addition, crisis simulation and war gaming enable management to understand what can happen, which steps to take, and whether the organization is truly prepared. On the other hand; Management's response can either contain or escalate an incident; indeed, a poor response can even create a crisis. Vigorous, coordinated responses to incidents limit lost time, money, and customers, as well as damage to reputation and the costs of recovery. Management must be prepared to communicate, as needed, across all media, including social media, in ways that assure stakeholders that the organization's response is equal to the situation.

Human Capital and Financial Resources

All given projects, initiatives and platforms require well prepared and professional staff/human and professional capital to maintain them and to assure that all services are being provided to people using them. UBT is able to cover, and is covering, all human requirements needed. These professionals are in charge to lead initiatives, projects, institutes, labs, centers and platforms, as well as to deliver tasks properly and to put other human resources in place whenever and wherever is needed. Furtherly, establishing and maintaining these structures, as well as assuring a proper service delivery of them require certain financial investments and maintain costs. However, based on its commitment to fully and effectively fulfill its 3rd mission towards society, UBT is also committed to, and is currently covering the all costs related to given structures. In parallel, AVR Platform is established and thus financed in partnership with EON Reality. When it comes to technological aspects of advanced smart applications, all Software, Online Platforms, Test Beds, Web-pages, PC Labs, Virtual Reality System tools and equipment, co-working areas, conference rooms, visualization and marketing means needed for the given structures are operating and being managed by UBT. The institution is covering all costs as an expression of commitment to fulfill its 3rd Mission in a fully and effective way.

1. Theoretical and Conceptual Framework of Smart Cities and Smart Development

By 2050, it is estimated that roughly 70% of the world's population will live in cities. With more citizens to serve, and a climate that is rapidly degrading, public service efficiency and effective resource-usage are becoming pressing issues for cities. In this context, ensuring sustainable development and quality of life in complex social ecosystems of cities and urban areas are important concerns. Cities are increasingly aware of the concept of "smart city" and are actively developing strategies towards the goal of becoming "smart" and manage city resources more efficiently while addressing development and inclusion challenges. To understand the concept of smart city, we begin with understanding the conceptual relatives of the model. Although limited in scope, they set the theoretical framework for the holistic notion of the smart city currently understood by the urban planning sphere. The notion of smart city is established from the combination of the knowledge society and digital city. It is defined as a "multi-layer territorial system of innovation" made up of digital networks, individual intellectual capital, and the social capital of the city, which together constitute collective intelligence (Komninos, 2008). Economic competitiveness and innovation achieved through the knowledge-based economy marks a city as intelligent, allowing it to generate a "spatial competitive advantage" through industrial districts, regions, and learning clusters that produce sophisticated R&D and are supported by digital networks and artificial intelligence (Komninos 2008). Based on the exploration of a wide and extensive array of literature from various disciplinary areas, the identified factors– Social, Management, Economy, Environment, Technology, Sustainability, (SMEETS) forms the basis of an integrative framework. This comprehensiveness is the distinguishing factor of the smart city, which integrates a number of physical, institutional, and digital components to create a holistic definition of what smart planning would look like.

1.1. Pillars of Smart City

At its core, a smart city framework leverages from the existing legal, economic and technical environment and impacts the social and management aspects in a sustainable manner[1]. Setting a smart municipality vision and effectively moving towards it with a systems-based approach is imperative to ensure optimum resource efficiency and security, along with preserving socially inclusive growth. Thus, the 5 pillars or factors of Smart Municipality are: (1) Smart Governance (Management), (2) Smart Public Infrastructure Services (3) Smart Transportation (4) Smart Economy, (5) Smart Environment, (6) Smart People & Smart Living.

Smart Governance[2]: "Smart Government" is about strengthening the connections and interactions between the government and all stakeholders - citizens, businesses and other organizations of the civil society - within a municipality. A municipal government following a smart city strategy is uniquely positioned to reconsider the quality, scale, and scope of services for citizens and businesses that it offers. Following a "city as a service" model can help to increase efficiency and effectiveness as well as transparency and trust. In this regard, smart public services, also known as digital public services or eGovernment, refer to the use of technology to provide services to citizens at local, regional and national levels. They bring many opportunities to both citizens and businesses: students can apply to study abroad, citizens can open bank accounts online, and workers can file taxes with the click of a button.

Smart Water Management: In simplest of words, a **smart water management system** is a concept that utilizes electronic and computerized engineering to increase information collection and analytics. Bigdata acquired from the system is used to maintain practical choices and upsurge the competence of water reserves[3]. As same as other smart infrastructure systems, Smart Water Management (SWM) uses Information and Communication

1 Moosavi, M.S., 2018. The Smart City; Challenges and Opportunities in Developing Countries. Iranian Online Journal of Urban Research, 3(1), pp.1-5.

2 The text used in this chapter is mainly based on two following sources: Smart City Indicators: Six Fields of Action for Success (beesmart.city) and Digital public services | Shaping Europe's digital future (europa.eu).

3 Smart Water Management: What You Need To Know | RPMANetworks

Technology (ICT) and real-time data and responses as an integral part of the solution for water management challenges. The potential application of smart systems in water management is wide and includes solutions for water quality, water quantity, efficient irrigation, leaks, pressure and flow, floods, droughts and much more. By applying SWM infrastructure such as sensors, smart meters, monitors, GIS and satellite mapping, and other data sharing tools to water management, real-time solutions can be implemented and broader networks can work together to reduce current water management challenges.

Smart Waste Management System[4] and Circual Economy[5]: Smart Waste Management (SWM) discusses the waste management process for different types of waste while introducing an intelligent approach to controlling the amount of waste. Thus; A smart waste management system, as a component of a broader "Smart Environment" initiative, should effectively integrate technology, data collection, and sustainable practices to optimize waste handling and enhance urban livability. This system is based on the following pillars: Advanced Data Collection; Automated and Optimized Routing; Recycling and Waste Segregation; Public Engagement and Education; Energy Recovery and Waste-to-Energy Solutions; Regulatory Compliance and Reporting. By implementing these features, municipalities can create a smart waste management system that not only efficiently manages urban waste but also contributes to the overall sustainability and resilience of the community, reducing environmental impact and improving the quality of life for all citizens. On the other hand; the **Circular Economy[67]** is a sustainable development strategy that aims to redefine growth, focusing on positive society-wide benefits. It entails gradually decoupling economic activity from the consumption of finite resources, and designing waste out of the system. Unlike a traditional linear economy, which has a 'take, make, dispose' model of production, a circular economy is based on three core principles: design out waste and pollution, keep products and materials in use, and regenerate natural systems. In a circular economy, the lifecycle of materials is maximized, meaning that products are designed and optimized for a cycle of disassembly and reuse. This systemic shift keeps resources in use for as long as possible, extracts the maximum value from them whilst in use, and then recovers and regenerates products and materials at the end of each service life.

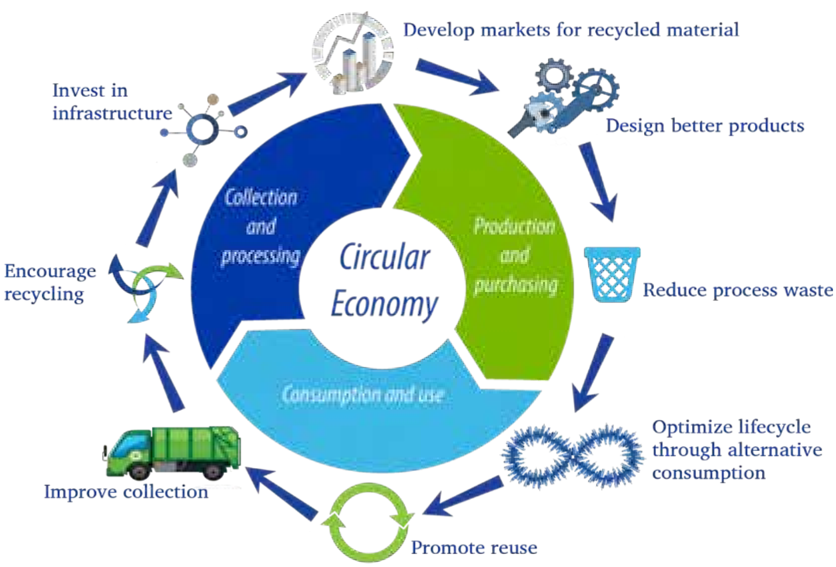


Image: Sustainable Global Resources Ltd. Recycling Council of Ontario

The role of Industry 4.0 (I4.0) on 3Rs (Reduce, Reuse and Recycle)

4 https://www.sciencedirect.com/science/article/pii/S0956053X23005573
5 https://climatepromise.undp.org/news-and-stories/what-is-circular-economy-and-how-it-helps-fight-climate-change
6 https://www.researchgate.net/publication/306924920_Smart_Economy_in_Smart_Cities
7 https://www.oecd.org/cfe/regionaldevelopment/Ekins-2019-Circular-Economy-What-Why-How-Where.pdf

The role of Industry 4.0 (I4.0) technologies, particularly the Internet of Things (IoT), in waste management emphasizes enhancing the Reduce, Reuse, and Recycle (3Rs) approaches through advanced digital solutions.

Reduce: IoT technologies are instrumental in reducing waste by enhancing resource efficiency in various sectors. For instance, IoT-enabled smart fridge architectures help minimize food waste by monitoring expiry dates and consumption patterns, thus prompting more mindful consumption and purchase decisions.

Reuse and Repurpose: IoT also facilitates the reuse and repurposing of materials. Innovative uses of IoT include transforming agricultural waste into valuable products like compost or liquid fertilizer through smart processing technologies. Digital platforms can connect local retailers to promote the reuse of food products that might otherwise go to waste, exemplifying how IoT aids in creating circular economies at local scales.

Recycle: In terms of recycling, IoT enhances the efficiency and effectiveness of waste management systems. Smart bins equipped with sensors can classify waste more accurately, which improves recycling rates. Technologies like blockchain and AI integrated with IoT further refine the recycling process by automating sorting and enhancing the traceability of waste materials. This technological integration ensures that waste is handled more efficiently, reducing contamination and improving recycling outcomes.

Smart Energy Management[8]: With the growth in world's population and the increasing global demand for energy, one of the greatest challenges of humanity is to ensure the balance between the environment and energy. As a result, using fossil fuels is no longer an alternative neither in terms of environmental protection nor in the construction of smart cities, so a handy solution to meet the energy demand is to use renewable resources such as solar, wind, hydropower and biofuels. Furtherly; all 6 of the main variables of Smart Municipalities need energy in different forms and modes, making it the key to sustainable development. Smart Energy involves more professional approaches that focus on adopting solutions based on an integrated approach to energy issues as crucial aspects in the sustainable development. Thus; Smart Energy Management (SEM) systems are crucial in optimizing energy use, enhancing sustainability, and reducing costs. These systems utilize Internet of Things (IoT) technologies to monitor and control the energy consumption of buildings and homes in real-time. For example, the Honeywell Building Management Systems offer solutions that integrate energy measurement tools with automated controls to enhance energy efficiency across various facilities[9].

Smart Mobility: Smart Mobility focuses on increasing the efficiency and service quality of urban transportation to enhance the use and adoption of new mobility solutions as well as to increase people mobility through efficient mobility management and targeted infrastructure investments. It also means achieving cheaper, faster, and environmentally friendly mobility as well as integrated multi-modal transportation.[10] Smart Mobility leverages the available technologies to gather and provide information to users, planners and transport managers, allowing the reshaping of urban mobility patterns, of planning mechanisms and the enhancement of multimodality by improving the coordination and integration of different transportation modes. **Intelligent Transportation System (ITS)** is often related to smart transportation. An intelligent transportation system is a technology, application or platform, that improves the quality of transportation or achieves other outcomes based on applications that monitor, manage or enhance transportation systems. Intelligent Transportation System relies heavily on data collection and its analysis.[11] Once the system is built to collect data and analyze it, the results are then used

8 https://www.researchgate.net/publication/372934843_A_Study_on_Smart_Energy_Management_Framework_Using_Cloud_Computing

9 https://buildings.honeywell.com/us/en/brands/our-brands/multisite/services/energy-management

10 Maldonado Silveira Alonso Munhoz PA, da Costa Dias F, Kowal Chinelli C, Azevedo Guedes AL, Neves dos Santos JA, da Silveira e Silva W, Pereira Soares CA. Smart Mobility: The Main Drivers for Increasing the Intelligence of Urban Mobility. Sustainability. 2020; 12(24):10675. https://doi.org/10.3390/su122410675

11 https://www.aindralabs.com/what-is-intelligent-transportation-system-its-applications-and-examples/

control, manage and plan transportation. Sensors play an important role in data collection. Since there is an inseparable conceptual bond between Sustainable Transportation Systems and Smart Transportation, below are mentioned various components of Sustainable Transportation Systems that work together to reduce environmental impacts, enhance mobility, and improve the quality of life: **Accessibility**; **Park and Ride Integrated Multi-Modal Transport Systems; Green Vehicles**; **EcoMobility; Organic Transportation etc.**

Smart Cultural Heritage Management
Vattano (2014) asserts that the integration of a city's historical elements into its modern reality is a significant factor towards the advancement of its urban intelligence. The specific benefits of including cultural heritage in smart initiatives derive from big data management and augmented reality (AR). Big data management allow to store and administer great amounts of data, beneficial for the preservation of cultural heritage, and the sustainable monitoring of its life cycle conservation[12]. Meanwhile, optimizing technological use in cultural heritage management leads to cost reduction in terms of maintenance. Further, Municipalities through smart initiatives could advance cultural heritage ontologies with AR characteristics allowing both citizens and visitors to readily access their historical value. **There are two main tools municipalities can use for Smart Cultural Heritage Management**, namely a) **Digital Interactive Map of Cultural Heritage and b) Virtual Museums.**

Digital Interactive Map of Cultural Heritage is another important tool of smart management of cultural heritage. It is a web application that combines online maps, digital archives and multimedia. This map focuses on research, digital preservation and visualization of cultural heritage, both tangible and intangible. It aims at allowing users to explore and better understand cultural heritage. Provides an opportunity for citizens to interact with cultural heritage in an easily accessible and stimulating format, while also enabling spatial analysis related to cultural heritage. This map also enables data collection and analysis of the spatial distribution of cultural heritage- both tangible and intangible in the territory of municipality.
On the other hand; **Virtual Museum** is among the main tools that Municipalities can use in their way of adopting smart management system approaches towards their heritage. It is a digital entity that draws on the characteristics of a museum, in order to complement, enhance, or augment the museum experience through personalization, interactivity and richness of content[13]. It's a collection of digitally recorded images, sound files, text documents, and other data of historical, scientific, or cultural interest that are accessed through electronic media[14]. The goal of the virtual museum is not to compete with or replace traditional museum visits, but to enhance, complement, and augment the museum experience by offering a level of personalization, interactivity, and richness of content that is impossible to bring in the real world. Thus, they need to be seen as a coequal to traditional museums[15].

Smart Economy
Smart economy is an economy that is based on technological innovation, resource efficiency, sustainability and high social welfare as engines for success. It adopts innovation, new entrepreneurial initiatives, increases productivity and competitiveness with the overall goal of improving the quality of life of all citizens[16]. Smart economy is expected to generate more products and services with less energy and pollution, and create social benefits. Smart economy should result from improvement of education and promotion of innovation[17]. **Smart**

12 Angelidou, M., Karachaliou, E., Angelidou, T. and Stylianidis, E., 2017. Cultural Heritage In Smart City Environments. International Archives of the Photogrammetry, Remote Sensing & Spatial Information Sciences, 42.
13 What is a Virtual Museum? | v-must
14 Museums (ubt-uni.net)
15 Museums (ubt-uni.net)
16 Information and communication technologies developing smart economies | The Sunday News
17 Digital Social Innovation for Better Connected Government: The Case of Republic of Macedonia: Government & Law Book Chapter | IGI Global (igi-global.com)

Economy describes all actions aimed at transforming and strengthening a city's economy, including improving the overall business climate, a city's attractiveness for start-ups, investors, businesses, and new (highly qualified) talent as well as growing the economy in an innovative and sustainable way to increase competitiveness. To achieve the desired objectives of Smart Economy, cities should focus on the following areas[18]:

AREA 1: Entrepreneurship | Productivity | Competitiveness: urban organization that fosters new entrepreneurial initiatives, an increase of competitiveness and high productivity in communities with the aim of improving the quality of life. In these terms, a smart municipality highly values creativity and welcomes new ideas, as well as enlightens entrepreneurial leadership.

AREA 2: R & D | Urban Labs: offer a solution which can be adopted by other universities or cities, and thus obtain a return on investment (ROI are its acronym in English) through the creation of innovative services and urban laboratories. In these terms, municipalities should be driven by innovation and supported by universities that focus on cutting-edge research, not only for science, industry, and business but also for cultural heritage, architecture, planning, development, and the like.

AREA 3: Tourist attraction and internationalization: Brandings which will provide a national and international perspective for the tourist promotion both social and economic. In these terms, a smart city is a destination that people want to visit (tourism).

AREA 4: Trainings and Life Long Learning | Smart Labor Force involves multiple components aimed at enhancing community engagement, personal development, and career progression through innovative educational technologies and customized training programs. These include actively assessing community training needs, integrating advanced educational tools such as AI and VR, and creating age-appropriate, inclusive learning modules for all demographics. Additionally, developing partnerships with industry ensures the relevance of training programs and provides practical experience, while strategies for attracting and developing local talent contribute to the region's attractiveness as a business location.

AREA 5: Smart Industry | Industry 4.0 or commonly known as the industrial internet of things (IIoT), describes the application of internet of things technologies in industrial processes and manufacturing. By implementing solutions/ concepts related to big data, machine learning, digital twin, artificial intelligence, predictive analytics etc., manufacturers aim to achieve the optimal level of responsiveness, adaptiveness and fully connected processes of a smart factory.

AREA 6: Smart Work Management | as per private sector, Smart Working means a new flexible working method. It is a new way of approaching work that gets rid of inflexibility and predetermined patterns in favor of focusing on what is relevant: ideas, projects and people.

Smart Environment

Smart Environment uses data collection from utility networks, users, and air, water, and other city resources in order to establish main areas of action in urban planning and city infrastructure planning as well as to inform urban services managers to achieve a more efficient and sustainable urban environment while improving the citizens' quality of life. The sustainable and smart territory leads reflections on the use and production of green and renewable energies, on more sustainable methods of food production or on the use of new technologies in order to optimize the management of resources (energy, air, water, waste, etc.). Urban agriculture, for example, is at the crossroads of these major issues. Thus, water management, waste management, emission reduction and smart air pollution monitoring are among topics to be considered in this context.

18 Smart Economy: Economía Inteligente. UA Smart University

Smart Air Pollution Monitoring
Smart Air Pollution Monitoring is a very important component of Smart Environment. Smarter Technologies' smart air quality monitoring solution is able to detect carbon dioxide levels, noxious gases and pollutants, sending real-time data to a central management dashboard. It provides enhanced visibility, improved situational awareness and earlier indications of pollution hotspots. The prime objective is to provide cost-effective access to air quality data to every citizen of the city, integrated with an accountable solution-mapping ability. Power and communication will lay the foundation of the monitoring network. The citizens of a smart city shall remain informed and engaged about the air quality via a dense network of monitors lodged with high-efficiency micro-sensors. A centralized dashboard will make this data extremely accessible.

3. UBT "SMART City" Overview / Transformative Planning Principles and Spatial Systems adopted by UBT Campuses

We are living in the times of convergence revolution which represents a very highly dynamic and complex environment. This dramatic transformation including using AI and other advanced technologies creates opportunities, but also new requirements for new competencies and skills. Traditional education is not enough today to provide the required future skills including skills adaptability, problem-solving, and collaboration. This requires a new solution for education, with highly complex and very dynamic-oriented models and systems. To support this causa, UBT – University for Business and Technology has created its model called UBT 5S – Small Scale Smart Selfsustained System or short UBT Smart City.UBT Smart City represents now an Entrepreneurial Smart and Sustainable Innovation Ecosystem. This model represents a dynamic complex system and is created to be used as a test bad system for smart and self-sustained solutions for education, innovation, and development. Made from different components for life and different technologies UBT Smart City creates a great opportunity to use Advanced and Innovation Technologies for Education, Training, Research and Development. Cases of using AI and XR Technologies in Education and their Impacts are presented to see the opportunities which is provided by UBT Smart City Ecosystem (Classroom 4.0). Classroom 4.0 provides many benefits, including an AI-powered immersive learning platform, the ability to quickly create courses for new types of job skills, cost-effectiveness, flexibility, real-time updates, accessibility, and inclusive retraining opportunities.

To support its mission of advancing and fully implementing smart systems in its everyday activities and processes, UBT has developed its Institutional Strategy and Action Plan for Green, Carbon-Neutral and Smart Campus. The Strategy and Action Plan focuses on nine key Initiatives, namely: Clean Energy, Building green, Getting around, Sustainable water management, Good food, Zero plastics, Smart technologies, Sustainable landscape, and Print responsibly. The given Initiatives-directly linked with certain SDGs- and related actions & project are briefly summarized below:

Clean Energy / Switch to Renewables: We'll transition to clean energy sources, reduce the campus's carbon footprint, and support sustainability by conducting an energy audit, installing solar panels, encouraging energy conservation, and exploring other renewable options.

Building Green/Green Building: Sustainable construction and ongoing green practices will reduce environmental impact and ensure long-term eco-friendliness through sustainable design, eco-friendly materials, energy-efficient systems, renewable energy integration, and ongoing maintenance.

Getting Around / Biking and Walking: Promoting non-motorized transportation options will reduce carbon emissions and foster a healthier lifestyle by developing a campus Master Plan, installing bike racks, implementing a bike share program, promoting biking and walking events, and integrating with public transport.

Never Waste a Drop / Sustainable Water Management: Efficient use, conservation, and recycling of water resources will conserve water, reduce costs, and minimize environmental impact through water audits, water-efficient fixtures, rainwater harvesting, improved irrigation practices, and community engagement.

Good Food, Healthy Planet / Zero Food Waste Campus: Sustainable food practices and reducing food waste will contribute to a healthier environment and carbon neutrality by implementing a sustainable sourcing policy, portion control, food recovery programs, composting, community education, and monitoring food waste.

Zero Plastics, Zero Waste/Single-Use Plastic Free Campus and Minimization of Disposable Items: Eliminating single-use plastics and minimizing waste generation will promote sustainability and environmental friendliness through a ban on single-use plastics, reusable items promotion, recycling and composting stations, waste reduction programs, and community education.

Adopting Smart Technologies/AVR: Integration of smart technologies will enhance efficiency, sustainability, and learning experiences by integrating smart building systems, incorporating AVR technologies, implementing IoT solutions, promoting remote learning, and developing smart campus initiatives.

Sustainable Landscape / Open and Green Areas: Creating and maintaining sustainable outdoor spaces will enhance the quality of life and promote biodiversity by using native plants, implementing water-efficient irrigation systems, creating multi-functional spaces, and engaging the community.

Print Responsibly/Save the Planet: Reducing paper consumption and minimizing the environmental impact of printing will conserve resources and promote sustainability through a print management system, digital document management, recycled paper and eco-friendly inks, a paperless initiative, and community education.

3.1. Embedded Emerging Technologies

UBT has embraced the **UNIVERSITY 4.0 Concept** as the foundation for its scientific, research, teaching, and innovation endeavors. This concept is actively implemented through a **Fully Digitalized Research and Education Process**, **CLASSROOM 3.0**, **Augmented and Virtual Reality (AVR)**, and the integration of a **5G Telecommunication Network**. These technologies are embedded within UBT's **Innovative and Scientific Campus in Lipjan/Kosovo**, as well as across its other campuses and facilities throughout the country. The campus itself is designed around the **small-scale smart city** concept, encompassing all spheres of life in an open and interactive environment. Fueled by technological advancements, innovative vision, and ongoing strategic initiatives, UBT has successfully transitioned to a **fully digitalized educational and research model**, prominently utilizing AVR technologies powered by the **EON Reality platform**. In this context, UBT is currently implementing **two major projects** centered on Virtual and Augmented Reality. The platform empowers both faculty and students across all disciplines to contribute toward simplifying and enriching everyday academic and research experiences.

The **UBT Smart Ecosystem University Model** integrates core principles of **Smart Systems, Resilience, Sustainability**, and **Society 5.0**, making it a globally relevant example of small-scale systems design. In alignment with its strategic direction and past achievements, UBT has recently established two pioneering institutes and laboratories in the fields of **Artificial Intelligence (AI)** and **Cybersecurity (CERT)**. These institutions reflect UBT's mission to foster an **integrative, creative, and transdisciplinary innovation ecosystem**, consistent with the **Convergence Revolution**. This environment is designed to unlock human potential—anchored in the belief that such potential is limitless. Moreover, cybersecurity plays a critical role in UBT's digital transformation agenda. The institution has established comprehensive **cybersecurity standards, tools, and protocols** to protect both digital and physical assets, in full compliance with international norms. UBT's **Cyber Crisis Management** approach is structured around two key components: **Readiness** and **Response**, both of which are outlined in detail.

Augmented and Virtual Reality (AVR) Platform: UBT is currently implementing two strategic projects focused on Virtual and Augmented Reality technologies in cooperation with **EON Reality (Prishtina, XK)**. This platform allows every faculty—students and staff alike—to actively develop, share, and apply educational and research-based content. Currently, the platform hosts over **1.8 million digital assets (2D, 3D, and 360°)**, with **approximately 40,000 new assets** added each semester.

5G Technology: UBT 5G Hub and Test-bed: UBT has launched a cutting-edge **5G Hub**, serving both internal (academic/research) and external (industrial) needs. As Kosovo currently lacks a 5G infrastructure, this hub is critical for future-oriented experimentation. Key capabilities include:

• Testing integration from **4G to 5G** networks for Internet Service Providers.
• Exploring **real-time communication** for **autonomous vehicles**.
• Facilitating **telemedicine** and **remote surgical simulations**.
• Testing **smart city solutions** for municipalities before full-scale implementation.
• Enhancing public/private transport systems through digital communication tools.
• Supporting **crisis communication networks** for national emergencies (medical, military, law enforcement, government, and media).
• Boosting service delivery by **centralizing servers** (Google, Facebook, Microsoft, etc.) and improving access speed by up to **300%**.

Fully Digitalized Education and Research: UBT's digitalization efforts, led by innovations such as AVR and supported by other smart technologies, have created a seamless 24/7 learning environment. Students benefit from real-time access to global scientific content, flexible study schedules, and personalized learning paths. This digital transformation enhances Accessibility and inclusion, Custom-tailored education**,** Access to AVR content**,** Cloud-based learning platforms**,** Internet of Things integration**,** Secure digital infrastructure, Big data analytics.

Strategic Institutes and Labs: In addition to previously outlined innovations, UBT has established the following hubs and institutes **Artificial Intelligence Institute and Laboratory; Cyber Security CERT Lab; UBT VR/AVR Hub; UBT Knowledge Hub; UBT Sports, E-Sports & Arts Hub.**

These are designed to reinforce UBT's commitment to the **4th Industrial Revolution** and the broader **Convergence Revolution**—enabling cross-sectoral, creative, and knowledge-based ecosystems for innovation.

Artificial Intelligence (AI) and Cybersecurity (CERT): These centers support both public and private stakeholders, including government bodies, military, and academia. Notable applications include:

• **Faculty of MBE**: Utilizes supercomputing for forecasting and service enhancement in the banking and finance sector; supports national cybersecurity efforts via the CERT lab.
• **Faculty of Architecture and Spatial Planning**: Leverages AI and drones for real-time 3D mapping and VR animation design.
• **Faculty of Mechatronics**: Applies AI to robotics, machine learning, and intelligent drone algorithm testing.
• **Faculty of Computer Science**: Develops AI applications for medicine, automotive, and technology sectors.
• **Faculty of Agriculture**: Uses AI and drones for soil fertility mapping and agricultural research.
• **UBT Stats Office**: Employs AI to refine and interpret large datasets for informed decision-making.

UBT VR/AVR Hub: Although still an emerging technology, VR and AR are no longer futuristic concepts. They are being actively used at UBT to solve practical problems and enhance interaction with the real world. As one of

EON Reality's top international centers, UBT has produced over **20,000 AVR lessons** across **20 different academic programs**, many of which are now part of featured global curricula.

This comprehensive approach underscores UBT's leadership in higher education digitalization and innovation—not only in the Western Balkans but also across Europe—further solidifying its role as a model for the Smart Ecosystem University of the future.

4. Challenges, Opportunities, and Transferability

Despite the integrative strengths of the UBT campus model, several challenges must be addressed to ensure long-term success and replicability. First; the **management of systemic complexity** poses difficulties in coordinating cross-domain data streams, infrastructure components, and stakeholder engagement. As Batty (2013) notes, cities—and by extension, campuses—are complex adaptive systems requiring non-linear and iterative governance models. Second; the governance of data, including issues of privacy, security, and interoperability, remains a significant barrier to fully operationalizing smart infrastructure (Kitchin, 2014). The challenge of **scaling** pilot innovations and interventions to whole campus area or regional implementation (always considering community's needs and expectations) requires institutional readiness, funding continuity, and administrative integration (Evans et al., 2019). Third; **digital inclusion** emerges as a critical issue, as emphasized by van Dijk (2020), since the benefits of smart systems must be equitably distributed among all campus users to avoid reinforcing socio-digital divides. Conversely, the UBT model presents valuable **opportunities** for innovation and policy learning. University campuses serve as ideal sites for **experimentation in urban resilience**, where modular, adaptive, and data-informed planning can be deployed and transferred (Karvonen, Evans & van Heur, 2014). The cross-sectoral nature of UBT's projects—engaging public institutions, tech providers, businesses, civil society, and local communities—supports collaborative innovation ecosystems, as core component of the process. Furthermore, the campus functions as a real-world interface for **policy prototyping**, facilitating agile testing of regulatory and planning frameworks in energy, mobility, and land-use systems.

Regarding **transferability**, the UBT framework offers a model adaptable to both local and global contexts. Its emphasis on tactical urbanism, integrated land-use, and community participation (although limited only to university community) aligns with principles of New Urban Agenda (UN-Habitat, 2016) and the EU's mission on Climate-Neutral and Smart Cities (European Commission, 2020). Thus, it is to emphasize that such university-based innovation ecosystems can be instrumental in supporting **institutional policy making in smart concepts and innovation strategies**, providing a scalable pathway for transitioning toward sustainable and inclusive urban futures.

5. Conclusion and Future Outlook

The UBT "SMART City" model represents a pioneering approach in integrating adaptive urbanism, circular economy principles, and smart infrastructure systems into a cohesive spatial and institutional ecosystem. As a transformative model, it redefines the role of university campuses from static educational environments to regenerative urban microcosms capable of responding dynamically to environmental, technological, and social shifts. Through its adoption of dynamic land-use modeling (Batty, 2009; Waddell, 2002), UBT has created a campus framework that enables continuous spatial adaptability and responsiveness to emerging demands, aligning with long-term sustainability goals. One of the key contributions of the UBT model lies in its operationalization of circular economy principles across campus infrastructures, drawing on theories of closed-loop systems to reduce waste and enhance resource efficiency (Ellen MacArthur Foundation, 2015). This has been translated into concrete actions in energy, water, food, waste, and material management, fostering synergies between environmental sustainability and everyday campus operations. Moreover, smart infrastructure deployments—including IoT-based environmental monitoring, smart building management, and integrated mobility systems—illustrate how technology can enhance campus resilience, optimize resource flows, and improve quality of life for all users (Batty et al., 2012; Neirotti et al., 2014). For planners, the UBT model offers a practical demonstration of multifunctionality and scalability in spatial systems. By designing hybrid-use environments that support education, housing, innovation, and public interaction, the campus becomes a living lab for spatial experimentation and an ideal ground for testing forward-looking planning strategies (Gehl, 2010; Sharifi, 2016). Technologists can leverage the model's integration of smart systems to explore new configurations of energy management, sensor networks, and data-driven service delivery, while simultaneously addressing challenges of interoperability, data governance, and inclusion (Kitchin, 2014; van Dijk, 2020). For educators, UBT offers a context where pedagogy is embedded within the physical and operational fabric of the campus itself—an experiential learning environment where sustainability, technology, and design converge. Policymakers are presented with a platform for policy prototyping and institutional experimentation. The UBT campus has demonstrated how regulatory frameworks in sustainability, transport, and land use can be tested at a micro-scale before being scaled regionally or nationally (Karvonen, Evans & van Heur, 2014). Its alignment with broader agendas such as the EU's Climate-Neutral and Smart Cities mission and the UN-Habitat's New Urban Agenda positions UBT as both a local innovator and a globally relevant actor (European Commission, 2020; UN-Habitat, 2016). Looking ahead, UBT's future development plan, encapsulated in its Strategic and Action Plan "Towards a Smart, Green and Carbon-Neutral Campus," provides a structured roadmap for deepening these innovations. Priorities include further integration of clean energy solutions, digitization of learning environments, expansion of green infrastructure, and institutionalization of sustainability governance mechanisms. Importantly, UBT envisions broader global engagement through knowledge transfer, cross-border collaboration, and participation in international research and innovation networks. As such, the UBT "SMART City" model is not only a physical manifestation of adaptive and intelligent planning but also a replicable and scalable framework that can inform future city-making processes. It illustrates how academic institutions can be reimagined as leading agents of spatial transformation, social innovation, and environmental stewardship in the era of climate change and digital transition.

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