



# THE EVOLUTION OF THE SMART WORLD – FROM SMART DEVICES TO SMART CITIES

## Abstract

The growing presence of IoT is bringing about an era of hyper-connectivity that is set to revolutionize how people consume services and products. After smart devices and connected appliances, customers now want smart buildings, campuses and even cities. However, the concept of smart cities is still riddled with ambiguity as it is a fairly new idea. This paper considers the fundamental aspects of smart buildings, campuses and cities (BCC). It also examines the technology enablers, features and the right approach that are vital to the success of smart BCC.



## Introduction

The word 'smart' can be used to describe many things, from a person's individual appearance to his mental acuity. For the economic marketplace, however, this simple word has taken on a more significant meaning in recent times, specifically to describe connected devices, buildings, campuses, infrastructure, and cities. As further advances happen in smart technologies, one may even foresee the emergence of smart countries across the globe.

For the sake of objectivity in the scope of this definition, let us focus only on the evolution of smart buildings, campuses and cities (BCC). A building can be defined as the basic tenet of a campus, which also involves features such as parks, recreation zones, etc. Applying the same principle, campuses form the basic tenet of a city, albeit at a different scale and augmented by an additional ecosystem. In fact, campuses can be considered as cities in a microcosm.

The concept of smart BCC is not limited to just the scientific, engineering or design

aspects. It requires a multi-disciplinary approach, which can be confusing for those seeking a clear definition of what smart BCC means. According to common definitions found in scientific and non-scientific literature, smart BCC comprises the following key aspects:

- Citizen-centricity – Citizens and residents are the main stakeholders and all developments and processes should be designed keeping this in mind
- Information and communication technology (ICT) – ICT should be used pervasively to plan, develop, monitor, and improve assets (such as infrastructure and the environment) as well as the services (such as policing and security) being offered to residents/citizens to enhance their quality of life
- Sustainable development – It is important to balance high quality of life with maintenance and protection of the overall environment while developing services such as social infrastructure and transportation

## Technology enablers for smart BCC

To understand the landscape of smart BCC, it is important to also understand the main technology enablers that drive this transformation. Having defined the framework of what constitutes smart BCC, these are the key technological forces driving change:

**1. The Internet-of-Things (IoT)** – The installation of connected devices in smart BCC is a key application of IoT technology. Sensors can detect and monitor the presence of people, light levels, humidity, fire, water, toxic gas, etc. Even services can be tracked through sensors to curate better experiences. This type of IoT-driven human and machine collaboration not only improves operational efficiencies and productivity but also creates new user experiences. However, the value of IoT does not lie in the mere installation of connected sensors but in how

data from these can be leveraged to continuously improve services, assets and quality of life

- 2. Big data and prescriptive/predictive analytics with AI** – With the availability of advanced tools that process data as well as algorithms that generate prescriptions and predictions, analytics models are growing in sophistication. Now, real-time situation monitoring enables proactive decisions based on historical data to ensure safe and efficient operations. The use cases for this include virtual concierges, smart resource and asset management, smart transportation, and smart policing
- 3. Cloud computing** – The on-demand availability of powerful SaaS, PaaS and IaaS offerings can deliver great value in smart BCC by enabling lean processes for security, utilities and resource management. This will steer

transformation to serve the needs of citizens/residents effectively

- 4. AR/VR** – AR/VR can be applied in predictive asset management and public works. It also has applications in areas such as improving digital interactions with residents/citizens, urban planning modelling, the quality of education and training programs, and how emergency situations are handled
- 5. Blockchain** – Blockchain can play a vital role to improve network and data security across all technologies. Next-generation blockchain is evolving into fast, fearless and miner-less (FFM) models. In fact, blockchains like IOTA and Hedera may not even use blocks and chains. It is important to identify the right on-chain and off-chain data and reinvent distributed consensus algorithm to drive blockchain adoption

6. **5G** – Next generation communication technology will increase the carrier bandwidth from 20Mhz in LTE to 400Mhz with speeds that are 10 to 100x faster than 4G/LTE. As latency reduces to mere milliseconds, ubiquitous 5G coverage will support pervasive communication across the entire BCC, even in high-speed trains moving at speeds of 500km/h

7. **Open standard architecture** – The arrival of open protocols such as BACnet and LonWorks has provided a common rule of interaction across various systems. These address adoption challenges arising from the lack of interoperability across different buildings and systems. Now, sensors, devices and systems can

seamlessly communicate, coordinate and integrate with each other. It even allows the pre-configuration of certain outcomes based on inputs from connected devices

8. **Next-gen power systems** – This is a concept called Power over Ethernet (PoE) whereby 60 watts of electric power and data can be transmitted over ethernet cables to power CCTV cameras, phones and lighting systems. PoE shifts the monitoring and control of power to the device level rather than area/sector levels. Communication and location-based technologies can also be deployed above lighting systems to gain more information and control



## Features of smart BCC

Taking the key fundamental aspects of smart BCC and pairing these with the technology enablers discussed above provides a rough idea of the features necessary to develop a smart BCC. Ultimately, the goal is to enhance the quality of life for citizens and residents in a sustainable and collaborative manner by improving efficiencies across all touch points between citizens, governance and the environment.

Smart cities – and, in effect, smart buildings and campuses – must possess the following features to be defined as such:

1. **Smart commercial, institutional, industrial, and residential buildings** – Reports indicate that by 2025, buildings will be the highest consumers of energy. However, nearly 50% of energy and water consumed by buildings are often wasted. The energy usage in data centers is increasing two-fold every 5 years and in the US, approximately 900 Million Metric Tons of greenhouse gases are being generated by commercial buildings alone. Thus, any smart city initiative should focus on optimizing energy use across all manner of buildings and residences. Some of the smart initiatives that can be implemented are:

- Smart workspaces including smart occupancy and space locators, smart socio-metrics, smart fitness tracking, smart colleague locators, smart meeting rooms, smart and connected furniture, smart air quality, smart lighting and heating, smart emergency indicators, on-demand services, smart connectivity through AV and 3D conferences, and automated Minutes of Meetings (MoMs)
- Smart homes that include smart appliances, smart security, smart entertainment, smart utilities, smart medical monitoring, and smart windows/doors/blinds
- Smart building services including smart fire/air quality/intrusion alarms and control, smart elevators, smart parking, smart HVAC, smart lighting, smart energy, and smart DG and UPS
- Smart commercial services including smart security and access control, smart helpdesk and smart industry equipment
- Smart environment monitoring including smart asset, space, waste and landscape management
- Smart citizen-centric services including smart direction and navigation, smart place and people finder, and smart emergency services

2. **Smart energy** – This focuses on optimizing energy usage and providing energy services in a reliable, sustainable and cost-efficient manner. It also focuses on renewable energy production for self-sustained communities. Some initiatives under this category are enabling smart electricity, gas, water, and lighting as well as use of solar and wind energy

3. **Smart mobility** – Intelligent and integrated mobility can increase access to public transport (transit-oriented development) with innovative solutions such as smart parking, smart traffic management, smart streets, smart intersections, and integrated multi-model transport facilities

4. **Smart governance** – E-governance initiatives that can be accessed through mobile phones and other devices will be important to make public services affordable and accessible to all citizens. Besides providing instant access to feedback from citizens, it also increases accountability and transparency. An integrated command and control center should be established to improve societal and traffic monitoring, policing and emergency services

5. **Smart infrastructure** – This allows digital management from planning till monitoring to track the health of critical infrastructural assets. Smart planning and asset management provides visibility into predictive maintenance capabilities. This also includes initiatives around smart landscape. Technological solutions can be used to monitor environment parameters like air quality as well as impending disasters such as landslides, avalanches, floods, and earthquakes in cities prone to such turbulences

6. **Smart healthcare** – This aims to enhance healthcare through integrated services as well as smart emergency medical services that use technology to improve access to health facilities, patient record management, diagnostics, treatment, and care

7. **Smart technology** – This encompasses the right technology mix to enable seamless wireless/wired connectivity between governments, citizens, city services, and infrastructure. It includes integrating information for real-time monitoring through a command

center and to identify trends, thereby improving service delivery and responsiveness in any situation

8. **Smart citizens** – While this is not related to technology, it may be the most vital aspect of smart cities. Digital initiatives and smart communities will only work when there is true engagement, adoption and participation among the citizens. Thus, the success of any smart city program lies firmly in the hands of smart citizens, not just in smart technologies

## Conclusion

As smart technologies pervade industries, services and products, the world is becoming increasingly interconnected and intelligent. The concept of smart BCC is shifting from R&D to academic research and into the agenda of policy decision-makers as well. The implementation of smart BCC offers tremendous benefits to citizens, governments and the environment. However, a one-sided top-

down approach that focuses merely on monetizing technology will not succeed. It is important to design any such initiative keeping the citizens and residents at its heart so as to drive consistent engagement. A balance between top-down and bottom-up approaches will create the right mix to ensure the success of smart buildings, campuses and cities.



## About the author



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