

Smart Living in Smart Cities

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ABSTRACT

As the global population increasingly gravitates toward urban centers, the concept of the “smart city” has evolved from a technological novelty into an urgent necessity. Smart cities are often heralded as the ultimate solution to the complexities of modern urbanization, promising enhanced efficiency, sustainability, and quality of life. A core pillar of smart cities is “smart living,” which focuses on enhancing the quality of life for residents through interconnected, data-driven solutions. Smart living encompasses various aspects of urban life, integrating technology to create a more seamless, efficient, and sustainable experience. The vision of smart living in smart cities offers a compelling blueprint for the future of urban development. This paper explores the multifaceted dimensions of smart living within smart cities and the critical challenges that must be addressed to realize its full potential.

KEYWORDS: *smart cities, urban areas, smart living.*

INTRODUCTION

As global populations continue to migrate toward urban centers, cities face unprecedented challenges in managing resources, infrastructure, and the overall quality of life for their residents. By 2050, it is estimated that 70% of the world's population will reside in urban centers. The rapid urbanization necessitates a paradigm shift in urban planning and management, giving rise to the concept of the “smart city.” A smart city is an urban model that leverages digital technology, human capital, and governance to improve sustainability, efficiency, and social inclusion. At the heart of this transformation is the concept of “smart living,” which focuses on utilizing these advanced technologies to directly enhance the daily lives of citizens [1]. Figure 1 shows that smart living is one of the major components of smart cities [2].

WHAT IS A SMART CITY?

Cities around the world are being wrecked by the ever-increasing burden of traffic. Smart cities are a recent innovation perceived as a winning strategy to cope with some severe urban problems such as traffic, pollution, energy consumption, waste treatment.

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Governments can streamline the way cities are run, saving money and making them more efficient as a result. The notion of the smart city captured most people attention during the last decade as a blend of beliefs on how technology in general could be used to transform how cities around the world work, while improving their competitiveness, offering new ways of solving problems linked to poverty, social deprivation, pollution and poor environmental issues [3].

The concept of smart city emerges as a major response to the increasing global urbanization, global warming, sustainable growth, scarcity of resources, and socio-economic challenges faced by cities worldwide. IBM's Smarter Cities work began in late 2008 as part of the Smarter Planet initiative. The idea of “smart city” first appeared in the 1990s, with focus on the impact of ICT on modern infrastructures within cities. It is the merge of some other more familiar urban policies such as digital city, green city, knowledge city.

The word “smart” can be used to describe any device that can process information and can communicate

with something. The term “smart cities” is a fuzzy concept and there is not a one-size-fits-all definition of the concept. The term has gained traction across sectors and has pervaded the fields of sustainability, urban planning, architecture, engineering, and computer science.

As typically shown in Figure 2 [4], a smart city is a high-tech urban area that connects people, information and technologies in order to increase life quality. It integrates ICT in a secure manner so as to manage the city’s assets, increase operational efficiency, share information with the public, and improve citizen welfare. ICT is the key technology that weaves digital intelligence into cities’ fabric. The main motivation for using ICT is the desire to eradicate human error. Smart cities are those communities that pursue sustainable economic development through investments in human and social capital and manage natural resources through participatory policies.

The main target for developing smart cities is to provide the following services [5]:

1. Convenience of the public services
2. Delicacy of city management
3. Liveable and sustainable living environment
4. Smartness of infrastructures
5. Effective integration of physical, digital and human systems in the built environment to deliver a sustainable, prosperous and inclusive future for its citizens.
6. Adequate water supply and electricity supply
7. Sanitation, including solid waste management
8. Efficient urban mobility and public transport
9. Affordable housing, especially for the poor
10. Good governance, especially e-Governance and citizen participation,
11. Safety and security of citizens, particularly women, children and the elderly
12. Health and education.

Figure 3 displays the six major characteristics of a smart city [6], while Figure 4 shows different elements of a smart city [7].

SMART LIVING IN SMART CITIES

The realization of smart living is fundamentally dependent on the Internet of things (IoT). IoT refers to the network of physical objects—devices, vehicles, appliances, and infrastructure—embedded with sensors, software, and connectivity that enable them to collect and exchange data over the Internet. In a

smart city context, IoT acts as the central nervous system, bridging physical infrastructure with digital platforms to create dynamic, self-optimizing urban environments.

At the micro-level, smart living begins in the home. Smart home technologies automate and optimize energy use, enhancing both comfort and sustainability. Internet-connected devices enable remote monitoring and management of appliances, heating, ventilation, air conditioning systems, and lighting. By tracking real-time power usage, these systems promote energy-conscious living and can significantly reduce carbon emissions. Furthermore, the integration of smart meters allows consumers to monitor their energy consumption patterns, fostering a culture of conservation [1].

TOP INNOVATIVE CITIES IN THE WORLD

The process of selecting smart cities can vary depending on the country, region, and specific objectives of the initiative. From Zurich to Copenhagen, we explore the cities redefining smart, green, and connected living. The top 10 innovative cities around the world are the following [8]:

1. Shenzhen-Hong Kong-Guangzhou
2. Tokyo-Yokohama
3. San Jose-San Francisco
4. Beijing
5. Seoul
6. Shanghai-Suzhou
7. New York
8. London
9. Boston-Cambridge
10. Los Angeles

For example, London has introduced groundbreaking initiatives, such as the Congestion Charge, contactless payments, and the Ultra-Low Emission Zone, key pillars of its sustainable urban model. Figure 5 shows London City [9].

Smart cities use IoT, data, and tech to boost sustainability, safety, and efficiency to improve infrastructure, services, and citizen well-being. Top US leaders include the following [10]:

- New York – smart grids, Wi-Fi, open data.
- San Francisco – bike-sharing, parking sensors, smart bins.
- Seattle – clean energy, EV charging, digital equity.
- Boston – smart lighting, free Wi-Fi, innovation labs.

- Chicago – IoT traffic, predictive policing, citizen engagement.
- Denver – smart mobility infrastructure, EV expansion, climate-focused digital governance.
- Los Angeles – adaptive traffic control, smart streetlights, large-scale sustainability initiatives.

For example, Seattle is often recognized as a leading smart city due to its innovative initiatives. The city is illustrated in Figure 6 [10]. Smart cities are transforming the way we live, work, and interact in urban environments. These cities increase their residents' efficiency and overall well-being by integrating technology, data, and connectivity.

APPLICATIONS OF SMART LIVING

Applications of smart living within smart cities include smart home technologies, energy management, healthcare, smart transportation, and public safety. Common applications of smart living include the following [1,11,12]:

- *Smart Homes:* The high rate of urbanization and technological progress has created the conditions for the emergence of smart cities, where new solutions are design to enhance the quality of urban life. Leading this revolution are smart homes—smart, networked residential areas with sophisticated automation systems and IoT technologies. Smart homes are part of smart cities, using advanced technologies to improve urban life by increasing energy efficiency, sustainability, and quality of life for residents. At the micro level, smart home technologies play a crucial role in smart living. IoT-enabled devices, such as smart thermostats, automated lighting, and intelligent appliances, learn user behaviors and adjust energy consumption accordingly. These systems can significantly reduce household energy waste. Smart home technologies form the foundation of an interconnected lifestyle. A primary application is the Smart Home Energy Management System (SHEMS), which monitors and controls energy consumption in real time. By connecting home assets to smart grids, cities can aggregate demand and measure usage patterns across multiple sites. For example, in Amsterdam, thousands of households have been equipped with smart meters and energy-efficient insulation, contributing to the city's broader sustainability targets.
- *Smart Healthcare:* Safety and health are fundamental pillars of a high quality of life. Smart cities utilize interconnected technologies to create safer environments and more responsive healthcare systems. Healthcare delivery is undergoing a profound transformation within smart cities. The convergence of urban infrastructure and digital healthcare—often termed “smart health”—aims to make medical services more accessible and efficient. Key applications include telemedicine, remote patient monitoring, and the integration of electronic health records. In healthcare, connected devices can provide real-time data to medical professionals, ensuring timely assistance and facilitating remote patient monitoring, which is particularly beneficial for aging populations. Healthcare in smart cities is increasingly proactive rather than reactive. Wearable IoT devices allow for continuous health monitoring, transmitting vital data to healthcare providers in real-time.
- *Smart Governance:* Smart governance leverages digital platforms to provide seamless services to citizens, from online payments to digital licensing. More importantly, it fosters citizen engagement. Boston exemplifies this approach by prioritizing citizen-centric design; the city conducts extensive neighborhood workshops before deploying new technologies and maintains a citizen oversight board to review data policies.
- *Smart Transportation:* Mobility is a critical component of the urban experience. Smart transportation systems utilize IoT to alleviate congestion, reduce travel times, and lower emissions. Key innovations include traffic lights equipped with sensors that adjust timing based on real-time traffic flow. Looking forward, the integration of autonomous vehicles (AVs) promises to further revolutionize transportation by reducing operational costs, minimizing accidents, and optimizing traffic flow. However, the successful deployment of AVs requires seamless integration with public transit systems to maximize benefits and prevent increased congestion. As shown in Figure 7, smart transportation is one component of smart cities [12].
- *Smart Lighting:* Smart street lighting also contributes to safety; these systems can automatically brighten in response to pedestrian movement or emergencies, and studies have shown they significantly deter crime in public housing developments. The *Chicago Smart Lighting Project* initiated in 2017 combated unreliable streetlighting problems to raise the standard of neighborhood life in Chicago, USA. The new lights consume nearly 50-75% less

electricity, saving energy costs by a lucrative margin to illuminate the streets.

- *Smart Parking:* One of the best uses of IoT in smart cities is smart parking. The bustling headland of the Sydney Harbor, the suburb of Mosmancity, implemented a comprehensive smart parking system in response to the city's congestion woes, with two major components – sensors (both overhead and in-ground) and a mobile app called *Park Mosman*. The installed sensors collect information in real-time to provide directional information and direct the drivers to available parking spots via the mobile app. This has helped the city council to manage the parking demand around the city's business centers efficiently. The smart parking system has also invariably reduced city congestion. The time spent on finding empty parking lots, and improved customer experience favorably.
- *Public Safety:* Enhancing public safety is a fundamental objective of smart living. IoT devices contribute to improved public safety through enhanced surveillance and emergency response systems. For example, smart streetlights equipped with environmental sensors and cameras can monitor public spaces and alert authorities to potential incidents. In the realm of public safety, connected streetlights, gunshot detection sensors, and intelligent video analytics allow law enforcement and emergency responders to react more swiftly to incidents. For example, Seoul has implemented environmental sensors and CCTV networks to monitor traffic and air quality, but also to protect its vulnerable populations. The city launched a safety initiative for senior citizens living alone.
- *Sustainable Environments:* Sustainability is a core objective of smart cities. Smart living empowers residents to reduce their ecological footprint while simultaneously lowering utility costs. Smart waste management systems utilize sensor-equipped bins that notify authorities when they are full, thereby optimizing collection routes and reducing operational costs. Additionally, the integration of renewable energy sources, such as solar and wind, combined with advanced battery storage systems, is essential for creating resilient and eco-friendly urban centers.

BENEFITS

The ultimate goal of a smart city is to enhance the daily lives of its residents. From energy-efficient smart homes to optimized transportation networks, the benefits of smart living are tangible and far-reaching. By integrating technology into the fabric of

urban life, smart cities offer profound improvements in mobility, environmental sustainability, public safety, and civic engagement. Other benefits of smart living include the following [1]:

- *Data-driven Decision:* The fundamental premise of smart living is that data-driven decision-making and interconnected infrastructure will create safer, greener, and more efficient urban environments. Through continuous data collection and analysis, city planners and residents can make informed decisions in real time. For instance, sensors can monitor traffic patterns, air quality, waste levels, and energy consumption. This data-driven approach is the cornerstone of smart living, allowing for the efficient allocation of resources and the enhancement of public services.
- *Citizen Engagement:* Beyond infrastructure and services, smart living fundamentally alters the relationship between citizens and their government. Digital platforms, open data portals, and e-government services make civic participation more accessible. Residents can easily report issues, pay bills, and access city data, fostering a sense of transparency and trust.
- *Quality of Life:* Research indicates that “smart living” is often synonymous with an enhanced quality of life. A study on the domains of smart living identified housing, health, safety, education, and social cohesion as critical indicators of resident satisfaction. By automating mundane tasks and improving urban efficiency, smart cities give residents back their most valuable resource: time. However, it is crucial to recognize that the benefits of smart living must be equitably distributed.
- *Energy Efficiency:* Energy efficiency is a paramount concern for smart cities. Innovative approaches, such as Amsterdam's vehicle-to-grid integration, allow electric vehicles to feed surplus power back into the municipal grid during peak demand, effectively turning cars into mobile battery storage. At the building level, smart home automation empowers residents to monitor and control their energy and water consumption via cloud infrastructure, contributing to broader city-wide sustainability goals.

CHALLENGES

While the vision of smart living is compelling, its implementation is fraught with technical, governance, social, and security challenges. Challenges concerning high implementation costs, data privacy, cybersecurity, digital divide, infrastructure, system

integration, and social equity remain. Other challenges of smart living include the following [1]:

- *Data Privacy:* The most significant concern surrounding smart cities is the extensive collection and processing of personal data. The vast amount of information gathered by IoT devices creates vulnerabilities related to privacy, government surveillance, and cybersecurity threats. Striking a balance between effective urban monitoring and the protection of individual privacy is critical. Robust security measures, encryption protocols, and transparent data governance policies are essential to maintain public trust.
- *Cybersecurity:* The omnipresent collection and transmission of data in smart cities introduce unprecedented vulnerabilities regarding cybersecurity and individual privacy. The interconnected nature of IoT devices expands the attack surface for cybercriminals. Successful cyberattacks on municipal infrastructure can cripple essential services, highlighting the urgent need for robust cybersecurity frameworks and zero-trust architectures. Smart cities employ integrated security systems that utilize surveillance cameras, biometric data, and IoT sensors to monitor public spaces.
- *Financial Constraints:* Developing and maintaining advanced infrastructure requires substantial financial investment, which can be a significant hurdle for many municipalities. Smart city projects require massive financial investments. To secure funding, cities frequently rely on public-private partnerships (PPPs) with global technology firms. While necessary, these partnerships often create power imbalances and conflicting interests. Technology providers are inherently driven by profit and the deployment of standardized, scalable solutions, whereas municipal governments must prioritize public value, equity, and local context. Aligning these divergent interests is a persistent challenge, compounded by bureaucratic processes and the long-term financial burden of maintaining and upgrading smart infrastructure.
- *System Integration:* Modern smart city projects typically integrate a multitude of advanced technologies, including AI surveillance, smart lighting, traffic management, and real-time analytics platforms. A primary technical hurdle is achieving interoperability among these disparate systems. For a smart city to function effectively, its various components must communicate seamlessly. However, proprietary technologies,

varying communication protocols, and a lack of universal standards often result in siloed systems that cannot share data efficiently.

- *Interoperability:* For a smart city to function effectively, diverse devices and platforms must work together seamlessly. Establishing standardized protocols for IoT devices is necessary to ensure compatibility and efficient data exchange across different municipal departments and private service providers.
- *Digital Divide:* A central critique of the smart city agenda is its potential to exacerbate existing social inequalities, creating a “have and have not” dynamic among urban residents. The “digital divide” refers to the gap between those who have access to high-speed internet and modern technologies and those who do not. There is a risk that the benefits of smart living may not be distributed equitably. Information and communication technologies (ICTs) are not uniformly accessible across all communities, potentially exacerbating the digital divide. Urban planners must ensure that smart city initiatives promote social inclusion and that marginalized communities are not left behind in the transition to digitally enhanced urban environments. A truly smart city is one that uses technology to serve all its citizens, not just the technologically affluent.

FUTURE OF SMART LIVING

The future of smart living is intrinsically linked to the advancement of artificial intelligence. AI and machine learning will transition cities from merely connected environments to predictive and autonomous ecosystems. Generative design algorithms will influence architectural planning, creating buildings optimized for energy efficiency and human comfort. Generative AI is top of mind for leaders around the globe who see its potential to shape the future. Ultimately, the integration of AI will enable cities to not only react to current conditions but to anticipate future needs, fostering environments that are deeply responsive to the well-being of their citizens.

The future of smart living in smart cities represents a profound reimagining of the urban experience. Driven by AI, IoT, and digital twins, cities of the future will be highly responsive, energy-efficient, and capable of mitigating the impacts of climate change and rapid population growth. However, the technological infrastructure is only half of the equation. As demonstrated by leading cities like Singapore, Amsterdam, and Boston, the success of a smart city depends on its commitment to sustainability, ethical data governance, and digital inclusion. To realize the

full potential of smart living, urban leaders must move beyond the allure of technology for its own sake and focus on human-centric design [1].

CONCLUSION

Seven out of ten people are expected to inhabit a city by 2050. Smart living in smart cities represents a profound transformation in how we interact with our urban environments. It specifically aims to improve the daily experiences, health, and safety of citizens by integrating technology directly into residential and public spaces. By harnessing the power of IoT, artificial intelligence, and data analytics, cities can become more efficient, sustainable, and responsive to the needs of their residents. Through the implementation of smart home systems, intelligent healthcare, optimized transportation, and enhanced public safety measures, smart cities offer a blueprint for sustainable and efficient urban environments. However, realizing this vision requires careful navigation of data privacy risks and a steadfast commitment to bridging the digital divide. As urban populations continue to grow, the transition toward smart living will be essential in ensuring that the cities of the future are resilient, sustainable, and capable of providing a high quality of life for all their inhabitants. More information on smart living in smart cities can be found in the book in [13-19] and a related journal: *Cities*.

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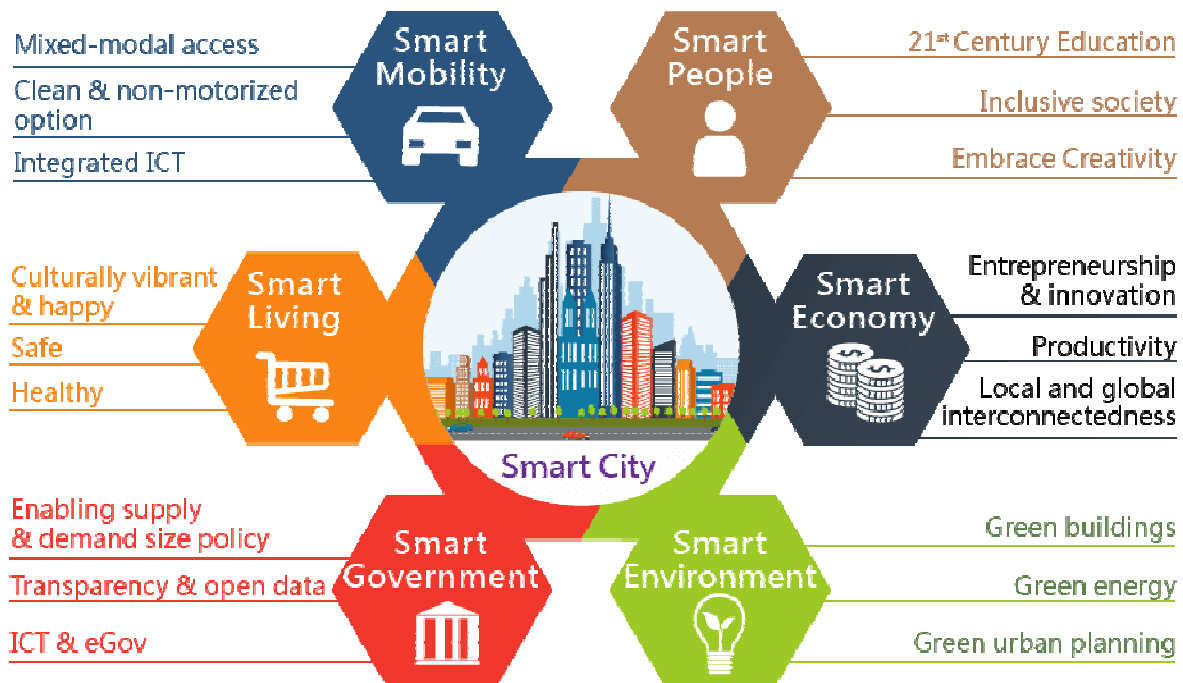


Figure 1 Smart living is one of the major components of smart cities [2].



Figure 2 A typical smart city [4].



Figure 3 The six major characteristics of a smart City [6].

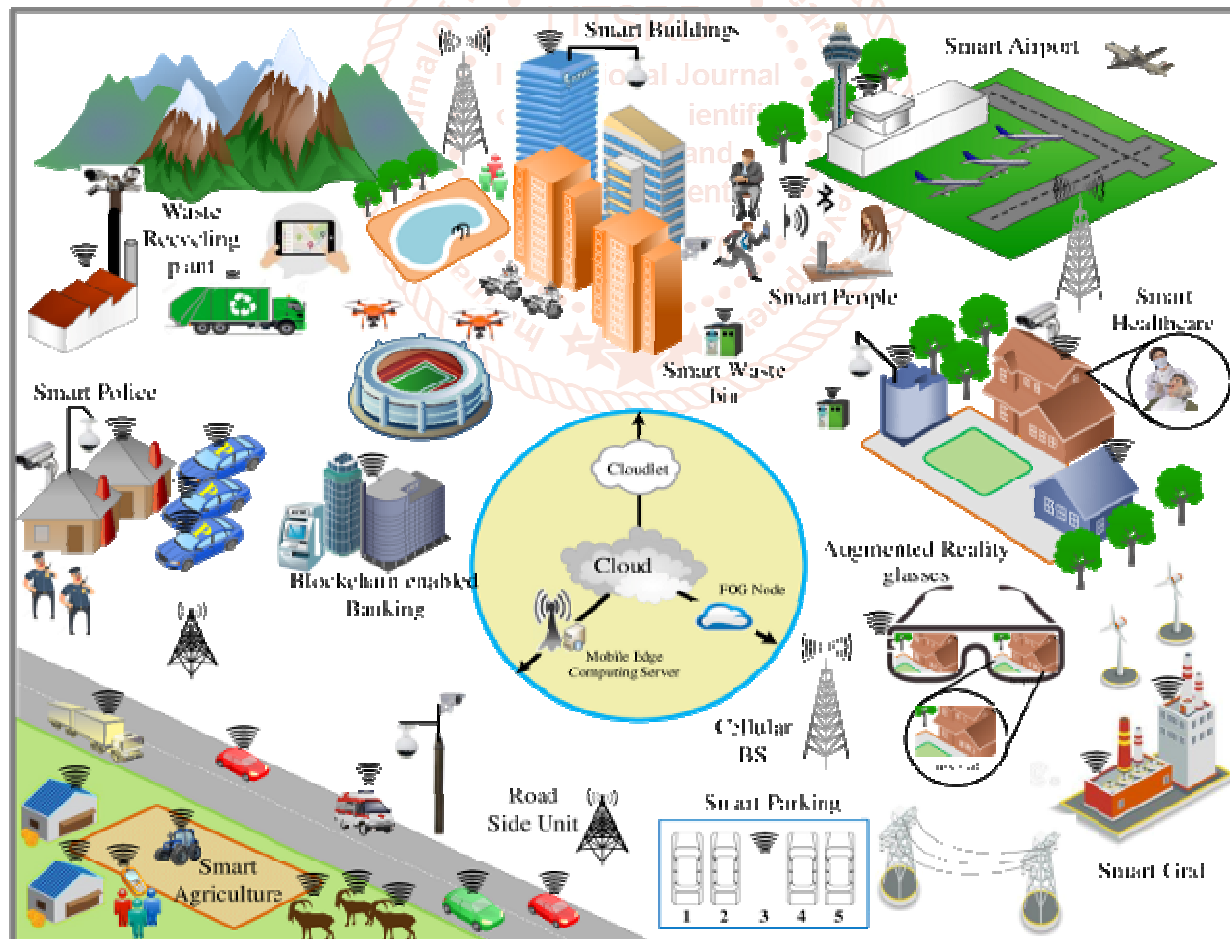


Figure 4 Different elements of a smart city [7].



Figure 5 London City [9].



Figure 6 City of Seattle, Washington [10].

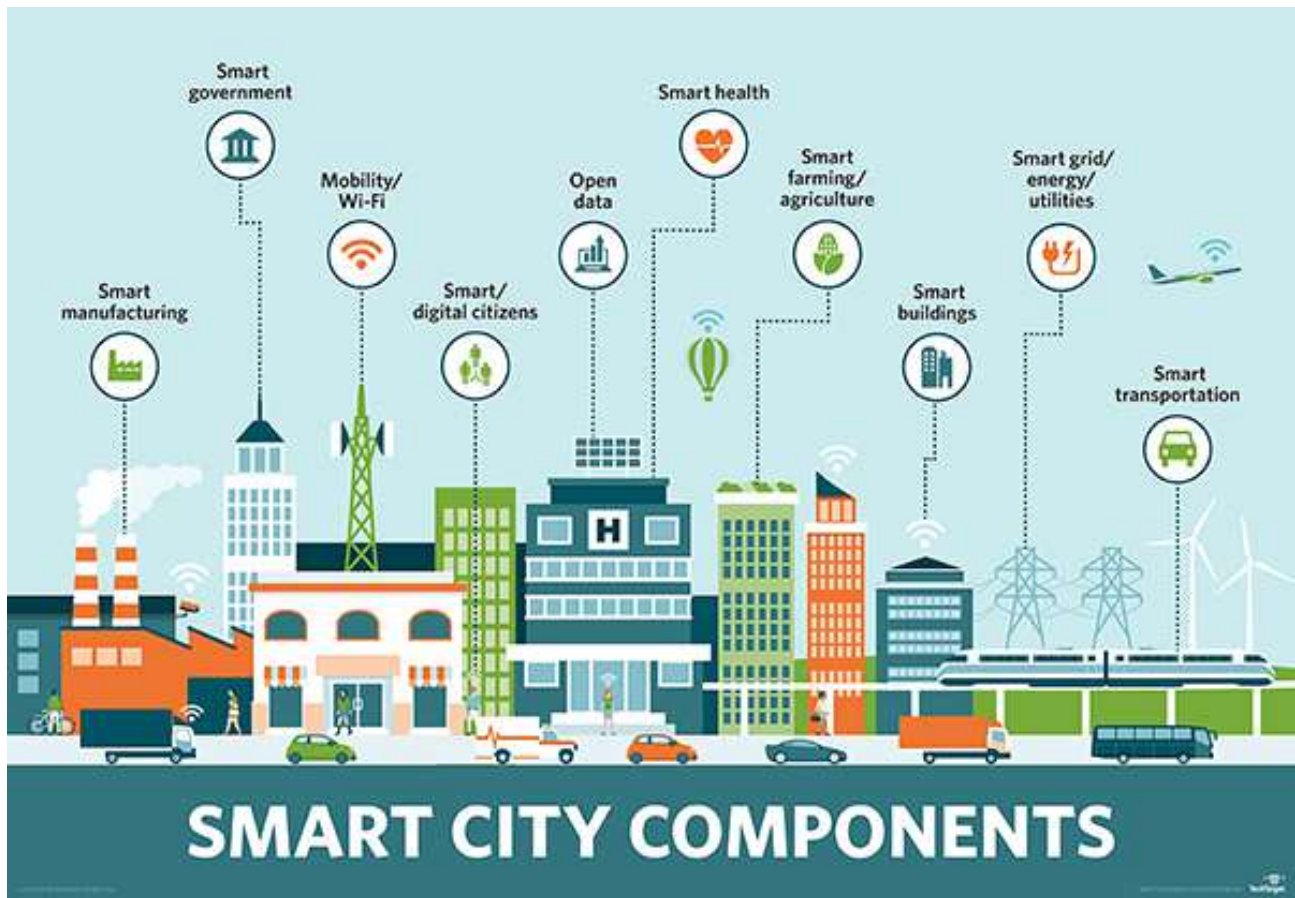


Figure 7 Smart transportation is one component of smart cities [12].