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# Study on Evaluation of Potentials and Challenges of Smart Cities in Contemporary Era

**Khandakar Akhter Hossain**
Vice Chancellor, Bangladesh Maritime University
Dhaka, Bangladesh
hossaindrakhter@gmail.com

**Sharmin Hasan**
Vice President (Health, Welfare & Counselling), BNFWA Central Committee
Bangladesh Navy Headquarters, Banani
Dhaka, Bangladesh
sharminhasan755@gmail.com

## Abstract

The use of smart technology presents many distinct potentials along with significant challenges in contemporary era. Those potentials included transforming industries, agricultural and service sectors by improving daily life with sustainability. These technologies develop smart homes, smart cities by improving healthcare, transportation, connectivity, finance, business etc. with comfort, safety and security. On the other hand, it creates challenges in technological, economical, legal and ethical facet along with data privacy, security, and accountability. Mobile phones, digital/quantum computers, camera surveillance, robotics, the Internet of Things (IoT), artificial intelligence (AI), machine learning (ML), big data, digital twins, and other cutting-edge technologies have drastically altered human culture, law, religion, employment, and other aspects of society. There are significant technical, financial, ethical, and legal repercussions to using these smart technologies in smart cities and commercial organizations. Smart cities in the 21st century utilize IoT, AI, ML, Big Data, Digital Twin, and data analytics to enhance sustainability, efficiency, and quality of life, with greater urbanization and climate challenges toward peaceful and smart living. Important prospects like intelligent traffic, smart grids, and citizen-centric services, though high implementation costs and cybersecurity risks remain significant challenges. Today, beside many prospects there are some major challenges need to handle to a balance between technological innovation and the protection of individual rights and societal values. This study will evaluate the potentials and challenges along with extensive use of smart technology to develop smart cities.

## Keywords
Smart technology, ICT, IoT, AI, smart city

## 1. Introduction

Smart technology now pervades every part of our life, altering everything from how we interact to how we handle legal matters. The Internet of Things (IoT), artificial intelligence (AI), machine learning (ML), and quantum technologies have made living easier and more pleasant. We use technology, such texting and video calls, to communicate with others rapidly (Hossain, K. A, 2015). Additionally, it facilitates the rapid retrieval of information using search engines like Google. We can now do activities more quickly and effectively because of technology. Today's society heavily relies on technology, which affects how you work, communicate, and make decisions. In the legal sector, technology is essential for addressing factual errors, preserving confidentiality, and enhancing data security (Hossain, K. A, 2015). Legal systems are increasingly using generative AI to automate processes like document creation and research assistance. Legal duty is called into doubt by this integration, particularly when AI

takes judgements on its own. Imagine, for example, that a Dhaka legal firm employs AI to design contracts. They have to make sure that a mechanism is in place to examine these papers and that the AI's outputs adhere to legal requirements (Hossain, K. A, 2025a). These days, smart cities use data from cutting-edge technologies like IoT, AI, and ML to improve environmental safety and cleanliness for their citizens. Some cities also deploy IoT or AI devices to suit the needs of their citizens and improve the efficiency of service delivery (Saaman Nadeem., Noor Ismail., Paridah Daud. and Tahir Mehmood., 'Emerging Technologies and Ethical Challenges in AI and Cybersecurity', 2025). However, despite their high level of security and connectivity, smart cities are vulnerable to a variety of challenges, including cybersecurity risks. However, by taking the proper safety measures, such risks and assaults may be prevented (Ron Chiong, 2016; eMudhra Blog, 2023). The increasing significance of focusing our lives on sustainability has led to the development of smart cities. These cities lower energy usage and CO2 emissions via infrastructure, innovation, and technology. A city is ranked higher than another based on a variety of criteria. A few important aspects are taken into consideration in order to accomplish this. Governance, public administration, urban planning, technology, the environment, international projection, social cohesion, mobility and transportation, human capital, and the economy are a few examples (Activesustainability, 2024). A smart city's primary objective is to maximize municipal operations, encourage economic expansion, and enhance people' quality of life using intelligent technology and excellent data analysis. The use of this technology determines it's worth (Blueiot, 2024).

Eighty percent of the world's nine billion inhabitants are predicted to live in cities by the year 2050. Nowadays, little over half of the seven billion people on the planet live in cities. Cities absorb 80% of the planet's resources while making up just 2% of its surface area. The traditional structures that cities depend on to deliver resources are unsustainable, as are the cities' fast development and disproportionate usage of social and physical resources (Nam, T., & Pardo, T. A, 2011a). Even while urbanization continues to contribute to increased global carbon emissions, local action is crucial to achieving a low carbon future. The legal industry is impacted by the growing trend of cities taking the initiative and creating plans to deal with the effects of computers. But as technology develops, ethics in technology need to be taken into consideration. Legal ethics today includes an understanding of how these developments impact accuracy, confidentiality, and privacy. Due to a lack of legally binding international climate action and a lack of leadership in many state governments, climate change is becoming increasingly apparent in our lives. In many respects, cities provide our greatest opportunity to address climate change (World Urbanization Problem, United Nations, 2014) (X Li et al., 'Internet of things to network smart devices for ecosystem monitoring', 2019).

Our global cities, which presently generate 80% of the world's GDP and serve as hubs for innovation and trade, will house 70% of the world's population by 2030 (World Bank). The way these cities look will have an influence on the environment worldwide, thus it is critical that we proactively decide what we want for our future cities and put in place systems today that service those needs in a sustainable and integrated form (Lombardi, P., Giordano, S., Caragliu, A., Del Bo, C., Deakin, M., Nijkamp, & P., Kourtit, K, 2011; Lee, Hoe S., Hoon Han, J., Taik Leem, Y. and Yigitcanlar, T, 2008). Future consequences include optimized energy usage and improved mobility, but also present serious challenges regarding data privacy, security risks like cyber security, digital divide and many uncertainties (Komninos, N, 2011). The concept of smart cities, also known as a city 4.0, should not be confused with sustainable cities, which seek to reduce the carbon footprint of their operations and promote efficient consumption and production patterns based on their geographic, social, economic, and cultural qualities. Smart cities, often referred to as advanced cities, significantly depend on technology-based tools and techniques to move closer to a future that is more efficient, safe, egalitarian, and ecologically friendly. This is accomplished by offering workable solutions that tackle typical problems in large cities, such as public services, employability, mobility, the economy, and citizen participation, among others.

The quality of life has significantly improved during the last century, mostly in terms of service availability. However, the robust industrial and population expansion in metropolitan areas have presented serious issues for administrators, architects, and urban planners. Transitioning to Net Zero via smart energy, waste management, and climate adaption measures is now a key emphasis (Hall R. E, 2000). To develop responsive urban settings, robots, artificial intelligence, and digital twins are being used more often. Public services, including traffic management and public transportation, are improved by real-time data collecting. Instead than focusing just on technology-driven projects, future development will priorities including individuals to make sure solutions address real requirements. However, a significant reliance on networked infrastructure creates weaknesses, making cybersecurity a major issue (Anthopoulos, L. and P., Fitsilis, 2014a). The huge amount of money required for development and maintenance causes problems for many of these communities. There are also a lot of moral and legal challenges. These legal nightmares include worries about intellectual property rights protection, privacy, and regulatory and compliance

challenges (Anthopoulos, L. and P., Fitsilis, 2014a). Meanwhile, the moral dilemma alternates between addictions, conscience, right and evil, and dignity. The main legal concerns are ensuring compliance with evolving regulations and applying existing laws to new, complex technologies. Evaluating smart city initiatives becomes difficult in the absence of agreement on measures (Anthopoulos, L. and P., Fitsilis, 2014b). It also makes comparing projects and identifying best practices more challenging. The solution is to turn smart cities into "smart regions"—for instance, by encouraging more collaboration between the public and commercial sectors (Wealth Management, 2025; City 4.0, 2025). These days, smart cities use ICT frameworks to create technologically advanced, sustainable infrastructure that tackles urban issues. This study looks at how smart technology has developed while assessing the difficult balance that must be struck between implementing these systems and upholding social norms and individual rights. It also emphasizes the need for sophisticated technological skills, which are critical for improving future citizens' competency and employability in this high-tech age.

## 2. Literature Review, Methodology and Research Questions

Smart cities aim to create more sustainable cities by using technology to enhance the quality of life for its residents. In order to securely and strategically integrate technology, information, and data solutions, several societal sectors must work together (Ron Chiong, 2016). Digitization drives smart city progress but introduces serious cyber risks, requiring 24/7 infrastructure protection. Ultimately, a "people-first" approach is essential—using data and technology purposefully to improve decision-making and quality of life. Let's take a closer look at what a smart city is and how digital solutions may support the development of a safe digital society there (eMudhra Blog, 2023). Because IoT devices are interconnected and use AI, smart cities are vulnerable to cyberattacks. It is crucial to safeguard the infrastructure from possible threats and secure the data that is sent between devices. To prevent unwanted access and preserve the integrity of the data gathered, smart cities must have strong cybersecurity measures in place, such as encryption methods, frequent software updates, and intrusion detection systems (Murthy; Trigyn, 2024). IoT and AI drive smart city innovation, but their expansion makes robust cybersecurity essential. The interconnectedness of AI-driven IoT devices makes smart cities highly vulnerable to cyber threats. To maintain data integrity and prevent unauthorized access, robust security—including encryption, regular updates, and intrusion detection—is essential. While these technologies enable everything from personalized commerce and drone delivery to traffic-reducing autonomous vehicles, their benefits depend entirely on the strength of the underlying cybersecurity infrastructure. Technology affects our behavior, challenges conventions, alters our capabilities, acts on our behalf, and produces biased results particularly with regard to human privacy and emotional and financial security.

In the twenty-first century, with 95% of the global population connected, ICT has evolved from a developmental tool into a profound force reshaping society, politics, and the environment. While technologies like AI, IoT, and robotics drive efficiency and ecological preservation, they also harvest vast amounts of sensitive personal data, necessitating strict global regulatory frameworks (Nagar, P, 2024). Modern smart technologies—including AI, IoT, ML, and big data—outpace human capability by performing complex simulations and calculations over 100 times faster (Taryn White, 2024; Deakin). By automating production and distribution, digitalization ensures that the manufacturing of goods and services is not only simpler and more precise but remarkably rapid. Because of its autonomous and effective nature, it can adapt to changes in the business climate, price, quality, quantity, and sort of products or services (Dante D. Sanchez-Gallegos, Diana E. Carrizales-Espinoza, Catherine Torres-Charles and Jesus Carretero, 2025). Environmental degradation is becoming a global issue. The literature estimates that if present emission rates continue, a trillion tons of carbon dioxide would be emitted by 2050, which might have a detrimental effect on human survival (Lashkarizadeh, M., & Salatin, P, 2012). In recent years, there has been research on the function and significance of ICT for various economic outcomes. Increased use of information communication technology (ICT) has been shown to have positive economic effects (Majeed, M. T. and Ayub, T, 2018). The legal and ethical implications of these developments cannot be disregarded in the age of smart cities, when the integration of IoT, AI, and other smart technologies promises previously unheard-of levels of efficiency and innovation. Questions around data privacy, surveillance, cyber security, and the ethical use of technology become more pressing as urban areas become more globally connected and accessible through the internet or web (Dickey; Webb, M, 2008).

In order to guarantee optimal technical performance and effective urban administration, a smart city uses a variety of electrical techniques and sensors, such as motion detectors for pedestrians and light sensors for automated systems, to gather real-time data. For example, a light-detecting sensor allows a city to automatically turn on the street lights as required (Activesustainability, 2024). A smart life, which will eventually be the only way to live, includes smart city solutions. Governments employ IoT technology for smart cities to make transportation and climate-related choices. The concept of a smart city requires the integration of several areas of knowledge. Included are public administration

and e-government. Recent developments in this field have made it possible for cities to create and deploy their own intelligent systems (Vicky Meek, 2022). Since developing a sustainable smart city is essential to a city's development, the new concept of a sustainable smart city must be incorporated (Blueiot, 2024). In the competition for smart technology, there is now a clear gap in the research, analysis, and evaluation of smart city prospects, potential, difficulties, and solutions. So, there are few specific questions need to solve as follows:

1) What does the term "smart city" mean in the age of smart technology?
2) What chances and possibilities exist for smart cities?
3) What potential obstacles may a smart city face?
4) How can a smart city be developed successfully?

## 3. Smart City in Contemporary Time

A smart city is one that integrates digital technology into its networks, infrastructure, and services to improve its efficiency and liveability for both businesses and residents. The European Commission states that smarter urban transportation systems, improved water and waste disposal facilities, more effective building lighting and heating methods, more proactive and interactive municipal management, and safer public areas are all necessary for a smart city. In other words, a smart and sustainable city uses information and communication technology (ICT) to improve efficiency, competitiveness, and quality of life while ensuring that the needs of present and future generations are met. Widespread home access, Wi-Fi in public areas, smart infrastructure, smart meters, the utilization of open data, and e-government solutions are all characteristics of a smart city, according to the United Nations Economic Commission for Europe (UNECE) (Klein, A.Z, 2022). The Smart City concept is currently a key component of sustainable urban development. It is a group of urban planning strategies with several wide benefits, including efficient resource distribution, prompt policy execution, seamless communication, and numerous environmental benefits. A city's "smartness" is determined by a variety of elements, including technology-based infrastructure, environmental initiatives, effective and highly functional public transport, innovative city planning, the capacity of its citizens to live and work there while making use of its resources, etc. The public-private sector's cooperation is essential to the development of a smart city since it takes a lot of work to create and sustain a data-driven environment (Blueiot, 2024).

A smart city is an advanced metropolitan environment that incorporates explicit data from sensors and several electrical systems. The knowledge gained from such data is employed to progress tasks throughout the city by effectively managing assets, resources, and administrations (Klein, A.Z, 2022). Smart cities and smart enterprises include AI, web technologies, smart mobile platforms, telecommunications, e-commerce, e-business, and other technology. This comprises information collected from inhabitants, gadgets, structures, and resources that is analyzed and processed for monitoring and management (Al Nuaimi E.). As shown in Figure 1 below, that smart technology fulfils the need for a smart city. Information and communication technology (ICTs) is used by smart cities to scale services like utilities and transport for a growing population. Growing urbanization and population growth are igniting a fresh interest in incorporating technology into the design of municipal services—the core of "smart cities" (Harrison). In order to detect variables like temperature, moisture, allergens, pollutants, traffic, and power matrix condition, smart cities mostly depend on sensors. These parameters' values provide a background that aids a system in comprehending a citizen's circumstances at any given time (City 4.0, 2025).

Nearly all large, well-managed smart cities use the multi-tier concept in an effort to combine the physical and ICT environments. But another intriguing strategy that combines automation, robots, artificial intelligence, and the Internet of Things seems to be being adopted by smart cities. Because of this, many smart cities can use data from sensors, buildings, and people as sensors in their applications without having to start from scratch with networks or other complex infrastructure. Any or all of the elements of smart cities might be incorporated into potential business strategies. For example, in smart cities, suppliers construct and install infrastructure, operators generate revenue by using these facilities or rendering services, service providers generate revenue by rendering their services, etc. To do this, a smart city may use a variety of modern business techniques. A city may be seen from a variety of perspectives, some of which already exist and others of which need design. The dimensions are:

1) The environment includes parks, buildings, lakes, rivers, and landscapes.
2) Public transportation is an example of infrastructure.
3) Open Data, innovation, synergy, cooperation, and creativity make up the Collaboration System.
4) E-government, e-learning, and e-traffic are solutions.
5) Living: working, recuperating, and having fun.

The interactions between the different disciplines in a smart city offer the greatest potential for value creation. Additionally, services made possible by technology should be mentioned while discussing smart cities. People and their needs are frequently disregarded in this situation. It is important to keep in mind that a smart city is built for the people, not for its own purpose. It is now necessary to connect disciplines and sectors that did not previously interact closely in a way that adds value. Smart city initiatives are frequently approached solely from a technological standpoint. Nonetheless, it is crucial to address a number of other non-technological factors, including organizational settings, societal culture, and the culture of city management departments (viz. municipalities, corporations, district councils etc.). As cities grow, smart solutions are essential to handle population density, moving from conceptual ideas to, in some regions, highly connected urban environments. While Western cities often focus on retrofitting existing infrastructure with smart solutions, other regions may focus on new, purpose-built smart developments (Webb, M, 2008; Zhang, C., and Liu, C, 2015).

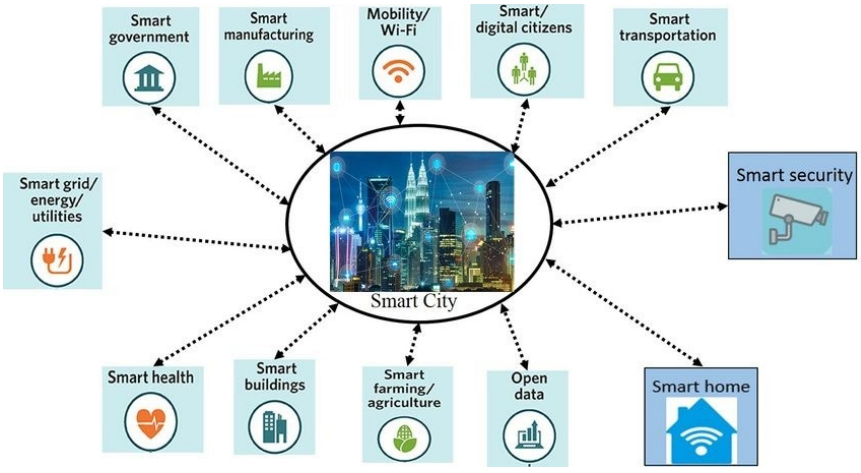


Figure 1. Smart technology solves the requirement of smart city (Sridhar C, 2023)

Smart Cities make life easier and better for those who live and work there by utilizing technology to enhance urban administration. They reduce their environmental impact by making the best use of natural resources. More precisely, sensors gather information from various urban locations, including hospitals, law enforcement, waste management, traffic, transit systems, and air quality. One of the Smart Cities of Europe is Barcelona. There are many different applications and services for smart city solutions. They can provide safer public areas, more efficient transportation networks, just-in-time waste management, better-balanced and less wasteful water supplies, and efficient building heating and lighting. All of this may sound futuristic, but many of the cities where we live have already adopted some clever solutions, like telemedicine, intelligent traffic signals, ride-hailing, emergency response optimization, and municipal water leak monitoring. Smart systems are being adopted by city planners and authorities at an increasing rate due to the numerous issues posed by rising urbanization rates. Over 60% of the world's energy is consumed in cities, which also produce 70% of its CO2 emissions. Reducing the footprint of big cities is crucial, as most governments have promised to cut national emissions. Another contributing cause is declining air quality, which results in health issues and restricted access to clean water. Perennial traffic and overwhelming trash management have long been serious problems that are getting worse. According to the World Economic Forum, the pace of urbanization worldwide is predicted to increase from 56.2 percent in 2021 to 70 percent by 2050. By that time, an additional 300 million people are predicted to live in cities in China and 400 million in India alone. North America's current high rate of urbanization (83.6%) is expected to rise even further.

Smart city transformation. The foundation of a smart city is 5G technology. In contrast to 4G, which only allows a limited number of connections, 5G is ten times faster, has low latency (i.e., there is only a small delay of 1 to 1,000 milliseconds before a data transfer begins following an instruction), and allows millions of devices and sensors within a one-kilometer square area. Several 5G-related technologies are needed for a smart city. For example, a city monitors traffic using a variety of Internet of Things sensors. Once collected, the data is sent across the 5G network. Throughout this process, blockchain technology may assist guarantee secure data transfer. Traffic authorities employ edge computing analytics to assess data in real-time in order to anticipate traffic flows and create practical congestion

management strategies, such as rerouting traffic or altering traffic signal sequences. Large volumes of Big Data can be efficiently processed using AI. After that, the dataset is securely stored on a cloud server for further use and study. There are a number of players and aspects involved in bringing Smart Cities into reality:

1) Manufacturers of 4G, 5G, and WIFI equipment and service providers meet the growing need for dependable high-speed connectivity by sending sensor data over their networks.
2) High-capacity telecom towers and data centers that support edge computing are examples of communications infrastructure.
3) Manufacturers of semiconductors that provide sensors for data collection Software firms that control devices and sensors and offer intelligent solutions.
4) Businesses that use cloud storage to store the encrypted data.
5) Cybersecurity firms that defend systems against hackers and attacks during the data collection, transport, analysis, and storage process Businesses that offer building management solutions to maximize facility operations, such as waste management, energy, water, and energy consumption.
6) Businesses that facilitate the transition to electric cars and smart grids.

Cities have always had a complicated personality. Cities must incorporate the use of big data and information and communication technology (ICT) into everyday operations and in achieving their urgent objectives if they are to become smart and sustainable—more financially successful, socially just, and ecologically sound. Future cities will be more livable if technological innovation is combined with smart connections that take use of the expanding Internet of Things to address the real problems of waste/pollution control, energy efficiency, and traffic congestion. Smart city efforts are always a "work in progress," but when they are executed with genuine business results and end-user expectations in mind, municipalities throughout the world stand a better chance of winning the most livable title. Therefore, via international trade systems like those provided by the WTO, smart cities as they are now envisioned and understood have immense potential to open up in the global economic arena. In the future, most people's lives—whether or not they reside in a city—will be directly impacted by the structure, operation, look, and atmosphere of cities. Today's biggest metropolitan marketplaces have already surpassed those of many countries. This article examines the importance, potential, and opportunities of smart cities for multinational businesses to tackle the problems of the twenty-first century, keeping in mind the previously described notion of smart cities.

## 4. Potential and Prospects of Smart Cities

Smart cities have the ability to drastically change urban life and promote long-term growth in the sectors that provide these solutions by making our surrounds safer, faster, and more efficient. The Internet of Things, which encourages systemic efficiency via constant connectivity, is the cornerstone of modern innovation. But as the digital footprint of our infrastructure expands, cybersecurity plays an increasingly important role. Strict best practices and AI-driven defence mechanisms are essential to protecting data and the essential technology that keep a contemporary city running. A smart city is an urban model that makes use of government, technology, and human resources to enhance social inclusion, sustainability, and efficiency—all of which are seen as objectives for cities of the future (Hossain, K. A, 2025c; Marchesani, F, 2023). Digital technologies are used by smart communities to gather information and provide services. IoT and smart technology integration provide previously unheard-of chances for increased productivity, sustainability, and quality of life as smart cities expand. There are several advantages, such as smart grids improving energy management and connected gadgets optimizing traffic flow. But this interconnectedness also creates new and complex cybersecurity challenges. Urban services may be optimized and development regions can be identified using this data (Paiho, Satu; Tuominen, Pekka; Rökman, Jyri; Ylikerälä, Markus; Pajula, Juha; Siikavirta, Hanne, 2022; Hossain MS). "The concept of smart cities emerged as a result of the quick adoption of information and communication technologies in global cities" (Batty, M.; Axhausen, K. W.; Giannotti, F.; Pozdnoukhov, A.; Bazzani, A.; Wachowicz, M.; Ouzounis, G.; Portugali, Y, 2012). Deakin and Al Waer define four components that contribute to the concept of a smart city: enhancing innovation and knowledge; integrating ICT into living and working settings; employing ICT in government operations; and using a range of electronic and digital technologies (Deakin, Mark; Al Waer, Husam, eds, 2011). The same elements that make smart cities clever and responsive, such as real-time data interchange and remote control capabilities, may be misused if they are not well protected (James, Peggy; Astoria, Ross; Castor, Theresa; Hudspeth, Christopher; Olstinske, Denise; Ward, John, 2021).

Every city's infrastructure is its foundation, and growth can improve current connections in a variety of ways, such as by implementing green buildings, waste management programs, and traffic regulations. For instance, making 80% of Singapore's buildings ecologically friendly is the current goal of the city's Green Mark certification program. By 2028, several billion connected IoT devices in business-savvy buildings will be powered by broadcast communications

systems, 5G, high-efficiency Wi-Fi, and smart utilities like water, garbage, and electricity, according to Gartner. Moving advances include platform assessment frameworks, IoT sensors for obstruction and wastewater detection, stopping sensor applications, lighting sensors, and fire detection frameworks. This might lead to future urban regions being closer-knit and more conservative (Andrea Sorri, 2024; Hossain, K. A, 2023b). Therefore, every resident of a smart city greatly benefits from smart infrastructure. Mart cities therefore offer its tenants a say. While local area network systems allow users to collaborate and share resources, applications allow locals to temporarily report local difficulties. Greater investment and transparency are fostering cooperative ecosystems in metropolitan areas. Metropolitan regions are getting ready to be more human-focused and multidirectional for the government, organizations, and citizens alike, thanks to new advances and open information (Selvan).

In addition to investing in sustainable energy, cities can employ development to monitor and improve energy use in real time. This involves the use of ethical and sustainable materials, carbon-friendly and resource-efficient strategies, frameworks powered by renewable energy sources, and cutting-edge innovations that adapt to their needs. According to Deloitte Insights, the energy transformation contributes to the construction of a circular economy by decentralizing the production of energy from limitless sources. This is getting ready for urban areas to become energy self-sufficient (Classcentral; Poongodi M). Smart cities utilize surveillance technologies like biometrics and facial recognition to improve crime prediction and emergency response, yet these must be carefully managed to protect personal freedoms and prevent social division. Beyond safety, urban planning is shifting toward resilience through decarbonization and the "15-minute city" model, which ensures daily needs are met within a short walk or bike ride. As climate change intensifies, cities are increasingly integrating green innovations like vertical forests and floating infrastructures to ensure a sustainable, biodiverse, and equitable future for all residents (Carayannis, E. G., Barth, T. R. and Campbell, D. F. J, 2012). Smart mobility leverages innovation to create efficient, resilient, and sustainable transportation systems, focusing on infrastructure, micro-mobility, and zero-emission solutions like autonomous vehicles and hyperloops. In these adaptable cities, intelligent traffic management and diverse transit options empower all residents while promoting eco-friendly movement (Bannister, F. & Connolly, R, 2012). Complementing this, e-governance fosters transparency and collaboration by utilizing blockchain and IoT for secure, decentralized agreements. These digital tools—ranging from online voting to robust information security—strengthen citizen participation and the development of an e-democratic society. Additionally, local e-profession centers, online retraining programs, and digitalization of corporate functions like burden filing and permitting contribute to financial growth and an innovative business environment (Nam; Tripathi G).

In a smart city, e-governance guarantees citizens' satisfaction, accountability, and openness. Waste production rises in tandem with the continuous development of metropolitan populations and purchasing culture. IoT sensors are used by sophisticated and intelligent waste management systems to accurately track waste pickup, provide residents with usage advice, and incentivize them with financial benefits. Reusing e-waste also allows people to exchange equipment for cash. Smart containers manage the quantity of waste and sort uncategorized rubbish (Poongodi M). By avoiding human interaction, artificial intelligence recycling robots precisely identify the types of materials during waste sorting, increasing total productivity and large efficiency. When combined, emerging waste management strategies lessen the impact of economic activity on the environment (Deakin). Effective trash management keeps the city clean and healthy for its residents. Europe has pioneered smart city initiatives by prioritizing sustainable, integrated urban transit and bottom-up development driven by citizens and the private sector. Success in North American examples like Canada’s "Smart Cities Challenge" and Los Angeles' GeoHub—which consolidated 500 datasets to dismantle silos—proves that modern infrastructure requires resident participation and interconnected platforms. Meanwhile, Barcelona redefined the model by reclaiming data control from private firms to ensure transparency and prioritize local businesses. Ultimately, a truly responsive city necessitates a cultural shift in governance that balances technological integration with the protection of individual privacy and social capital.

In contrast, Asian smart city development—notably in China and Singapore—is typically top-down, with central governments driving funding and regulation to enhance governance and infrastructure. While these models vary, a fully functional smart city requires a smooth flow of data and technology across public sectors like waste, power, and telecommunications (Selvan). Although heritage Western cities may take longer to reach this level of integration, the global landscape continues to evolve through these diverse regional strategies. Chicago’s smart city strategy centers on infrastructure investment, economic development, and community involvement, highlighted by its transition to an open fiber-optic ring and a modernized Smart Grid that empowers consumers through digital smart meters. To address connectivity gaps, the city collaborates with the FCC to dynamically share public safety radio spectrum for cellular use. The goal of the Smart Chicago Sustainable Broadband Adoption program is to promote economic growth in five

underprivileged Chicago areas, providing training and hardware to over 11,000 residents while relaunching energy benchmarking initiatives to prioritize decarbonization. Since companies and applications are developed on their open data platforms, Chicago sees an economic growth justification for data accessibility (Zekić-Sušac; Pacheco Rocha N), with outreach led by the Smart Chicago Collaborative, which is responsible for a large portion of Chicago's community engagement efforts (Dreamstime, 2024; Andrea Sorri, 2024). While Chicago measures success through cost savings—such as saving $400,000 by moving to cloud tools and utilizing the OpenGrid (formerly Windy-Grid) platform—quantifying the long-term impact of these diverse initiatives remains a significant challenge.

Singapore has evolved into a global benchmark for urban innovation by transforming developmental challenges—such as water scarcity and land constraints—into lucrative business opportunities through progressive leadership and a commitment to "life-ability." By integrating sustainable policies with advanced ICT, the city-state maintains a highly productive, innovation-driven economy that mirrors the R&D intensity of nations like the Netherlands (Hossain, K. A, 2023b). Central to this strategy is the Economic Development Board (EDB), which actively attracts foreign direct investment through targeted incentives, ensuring a steady influx of global expertise to bolster its skilled workforce. This holistic approach ensures that Singapore remains a "smart" city that prioritized not just technological efficiency, but a high quality of life that serves as a replicable model for urban centers worldwide. Businesses with significant R&D expenditures, advanced technology, and high productivity are of primary interest to the EDB. Foreign design and architecture also pique Singapore's curiosity. Singapore is constantly searching for talent (Chen; Selvan; Moveglobal, 2025). To draw gifted students and academics from the area and beyond, it offers unique programs. Today, smart cities are revolutionizing urban development by leveraging data analytics and diverse public-private partnerships to tackle local challenges like traffic, housing, and environmental risks. Global leaders are defined by specialized technological strengths: Helsinki leads with its "Helsinki 3D+" digital twin project, while Dubai focuses on AI and autonomous taxis. Other frontrunners include Seoul for Samsung-powered transit, London for open-data social participation, and Tokyo for Hitachi-driven disaster response. This competitive landscape is rounded out by cities like New York, Shanghai, Copenhagen, Oslo, and Singapore, which utilize advanced wireless management, Siemens-integrated transport, and urban mobility to enhance citizen quality of life and sustainable growth (Eremia M., Toma L., and Sanduleac M, 2017; Rochet C. and Belemlih A., J. C. Augusto, 2020).

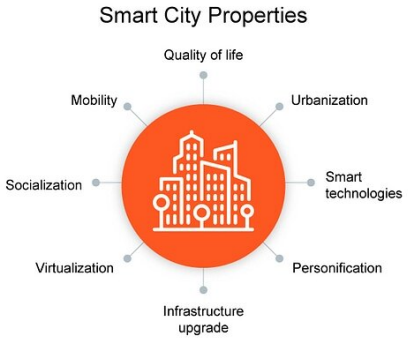


Figure 2. Potential and properties of smart cities (Sridhar C, 2023)

## 5. Challenges in Smart Cities

In smart cities, AI-driven healthcare advancements depend on large-scale data exchange, which frequently encounters hurdles regarding resident privacy and security. To address these concerns, researchers are investigating three primary mechanisms for privacy-preserving data handling. First, information can be "camouflaged" during collection to make it indecipherable. Second, privacy-preserving data mining ensures anonymity when sharing data with external parties (Soni, A, 2023; Zeng Q.), often through K-anonymity—a validation that an individual's identifiable attributes are identical to at least k-1 other clients (Hong). This is achieved by generalizing traits, introducing "noise," or periodically changing identifiers in crowded spaces to prevent long-term spatial tracking. Third, the results of data mining computations can be modified to limit the risk of re-identification while still meeting operational needs. Ultimately, success requires that city planners and tech providers maintain transparent security measures to ensure city residents understand the potentially sensitive information sharing that could occur with smart city developments (Deakin; Dante D. Sanchez-Gallegos, Diana E. Carrizales-Espinoza, Catherine Torres-Charles and Jesus Carretero, 2025). Smart city healthcare initiatives focus on improving usability and accessibility, yet high upfront development costs remain a

significant barrier to widespread adoption. While integrating ICT into large-scale medical systems promises long-term municipal savings, the initial investment often delays the deployment of these innovations. To address this, smart city platforms are shifting toward "plug-and-play" smart objects—adaptable, cost-effective technologies designed to blend into urban environments and provide healthcare services anywhere. Along with design observation, climate observation, security, and intelligent transportation, the things should aid in assessing well-being (Baba).

A Smart City needs "shrewd" citizens who actively participate in and effectively navigate new developments if it is to actually exist and thrive. Local communities are more willing to take advantage of developments and encourage others to do the same when they wish to influence the alternatives that affect daily life and are being passed on in a clever and pragmatic way. This is essential to the success of a Smart City (Technology HQ, 2025). Notwithstanding the wealthy and technologically advanced, it is crucial that Smart City orchestration incorporates the prospect, all else being equal. Development should always aim to bring people together rather than further dividing them based on factors like income or educational attainment (Hossain, K. A, 2025b). Examining these networks in relation to the various topics covered in this article will improve the overall result of a solution outside the domain of knowledgeable clients (Hossain, K. A, 2025d; Murthy). Smart cities integrate several fields, including transportation, energy, health, education, agriculture, business, social, banking, economics, and governance, to create a linked and intelligent metropolitan environment. The combination of data-driven solutions and smart technology in smart cities has the potential to drastically change urban life by providing people with customized and conveniently accessible services. However, despite the appeal of technology, creating a Smart City will not be easy. These challenges include data privacy concerns, unequal access to technology, and the need for collaboration across the public, business, and government sectors (Moveglobal, 2025; Bibri S. E, 2019). Since it is simpler to start from scratch than to restore outdated infrastructure, legacy cities face substantial challenges. In this sense, newer cities in the Middle East and Asia have a clear advantage (133). Another barrier that might make the acceptance of certain novel concepts more difficult is large populations (Trigyn, 2024). Smaller cities like Zurich (400,000) and Helsinki (1.3 million) could adopt new technologies more quickly. In the 2020 IMD Smart City Index, they came in second and third place worldwide, respectively. Here are some instances of common vulnerabilities:

1) Data breaches and privacy issues: Cybercriminals are drawn to the enormous volumes of data produced by IoT devices or AI systems. Individual privacy is seriously threatened by unauthorized access to sensitive data, which can result in identity theft or other nefarious actions (Goldsmith).
2) Infrastructure Vulnerabilities: Public services, electricity grids, and transportation networks are all susceptible to cyberattacks. The functioning of cities and public safety may be significantly impacted by disruptions in these vital services (Vanolo, A, 2014).
3) Device Manipulation: Malicious acts, such interfering with communication networks or changing data, can be carried out by compromised IoT devices or AI systems. The dependability and integrity of smart city operations are at stake as a result (Marsal-Llacuna, Maria-Lluïsa; Colomer-Llinàs, Joan; Meléndez-Frigola, Joaquim, 2015).
4) Denial of Service (DoS) Attacks: Critical services can be interrupted by flooding systems with so much traffic that they fail. This may result in grid outages, traffic jams, or compromised emergency response systems in the context of smart cities (Marchesani, Filippo, 2023).
5) Risks of Surveillance Systems: Smart cities and security technologies coexist. However, having inexperienced staff and ineffective processes can be risky and lead to cyberattacks even with the strongest technology defenses. In the event of a cyberattack, security and emergency alarm systems are the most vulnerable and might have the most effects (Lim, Yirang; Edelenbos, Jurian; Gianoli, Alberto, 2019).
6) Device Hijack: Because a smart city's infrastructure is made up of millions of devices, attackers often try to take over a device in order to obtain control. Because the item has continued to function as intended, users might not be aware that someone has taken control of it. Once in control, a hacker can take advantage of other networked devices. For example, they might utilize smart meters to steal electricity from a municipality or employ ransomware to threaten a city's energy management system (Deakin).

Deakin defines a smart city as one that employs ICT via community engagement to meet market needs (i.e., city inhabitants) (Ratten V, 2017). As an alternative to broad concepts that are difficult to define, studies of smart city projects may be utilized to define the notion of smart cities (Mahmud M. M. and Wong S. F, 2022). Data is collected from cameras, buildings, devices, and people. Smart cities may be used for a wide range of purposes, including traffic and transport systems, power plants, utilities, urban forestry, water supply networks, waste disposal, criminal investigations, information systems, schools, libraries, hospitals, and other community services (McLaren Duncan, Agyeman Julian, 2015). The cornerstone of a smart city is the integration of people, technology, and processes, which

connect and interact across industries including infrastructure, healthcare, transportation, and education (McLaren, Duncan; Agyeman, Julian, 2015). The monitoring, analyzing, planning, and controlling procedures used by local governments define smart cities. In a smart city, businesses, people, and other stakeholders that stand to benefit from its utilization share data (Musa). Public transport, outdoor lighting, and visual surveillance were the three primary sources of smart city investment as of 2022 (Paiho, Satu; Tuominen, Pekka; Rökman, Jyri; Ylikerälä, Markus; Pajula, Juha; Siikavirta, Hanne, 2022; IDC, 2022). ICT (information and communication technologies) and IOT-connected devices are used by smart cities to optimize municipal services and foster citizen interactions (Zhitao Li, 2026). ICT can enhance communication between the public and the government, reduce expenses and resource use, and enhance the performance, quality, and interactivity of urban services. Smart city applications provide rapid responses and regulate urban flows ("Building a Smart City; Matthew Marson and Mohamed Moselhy, 2025).

However, bogus data injection attacks over tracking devices in IoT systems may compromise the reliability and integrity of the whole Home Digital Twin ecosystem (Zeng Q.). Attackers alter system functionality by introducing fake information to contaminate IoT data streams rather than disabling hardware. These fake data injection attacks may result in anything from minor problems to whole system failures, depending on how significant the stolen data is. One common tactic is to intercept communications between devices and cloud platforms, such as by altering temperature, humidity, or energy usage sensors in a smart home to produce erroneous automated responses. The system may incorrectly construct typical ranges for environmental circumstances if an attacker introduces false data (Wachter). For example, if no one is home, a thermostat may be deceived into thinking the house is hotter than it really is by moving the heat to other rooms or levels. In the worst case, they might lead to even more dangerous safety risks, such a data breach that triggers false fire alarms, or catastrophic failures, like broken home systems. Redundancy and cross-checking by several devices are crucial protections against fraudulent data insertion (Zakerabasali). In addition to detecting variations between many sensors or devices recording the same data, this approach may identify outliers as potentially fraudulent data (Falkowski P.).

For example, when many smart thermostats in a building identify an unusual temperature differential, they may arrange an examination to verify the quality of the data. Similar data from several sensors might assist identify these wrong efforts to submit fake data, especially in areas where data manipulation is conceivable, such as security and health monitoring systems (Dhinakaran). Once again, these suspicious patterns of bogus data injection may be found using ML algorithms. By quickly detecting anomalous data values that depart from the anticipated pattern, these models are able to learn typical behavior. To handle the dangers of widespread monitoring, algorithmic prejudice, and the loss of human agency in smart systems, legal frameworks and ethical concerns must coincide. While laws in developing nations like Bangladesh seek to strike a compromise between individual rights and innovation, preventing socioeconomic inequality requires a comprehensive approach that prioritizes cybersecurity, transparency, and manual overrides. Technology may be used as a fair instrument rather than a source of discrimination if data protection authorities are empowered and UNESCO's ethical standards are adopted (Einarsen, S., Aasland, M. S., and Skogstad, A, 2007; Kellerman, B, 2004). Ultimately, further legal progress is required to protect privacy and secrecy while preventing AI from sustaining systemic discrimination in critical sectors like banking and law enforcement. Concerns of cybersecurity, the unlicensed practice of law via internet platforms, and the moral use of social media by attorneys are also relevant. Adopting ethical standards, keeping up with technical developments, and striking a balance between using technology for its advantages and respecting professional and ethical norms are all necessary for legal practitioners (Philippen Maisonneuve, 2024; Timespro, 2025).

## 6. Route to Make Successful Smart Cities

By 2030, 60% of the world's population is expected to reside in cities, according to UN projections. As a consequence, cities are increasingly using smart technology to address the complex problems caused by this rapid urbanization, such traffic, crime, and inefficient waste management. Given that global investment in smart projects is predicted to exceed $135 billion annually, the success of the city of the future rests on a well-thought-out, multi-level strategy that prioritizes the "human" side of urban life (Nele Coghe, 2021). To prevent talent from moving to competing locations, municipal officials must deploy a variety of integrated services that save infrastructure costs while simultaneously fostering economic growth and sustainability. By employing data-driven applications to optimize public transportation, emergency response, and essential utilities, cities can deliver the efficient, high-quality environments needed to satisfy and sustain their growing populations (Activesustainability, 2024; Adel A, 2023). Geospatial technology may help municipal authorities achieve their smart city objectives by converting location-based data into location intelligence to promote safety and quality-of-life-related city improvements. For instance, intelligent

monitoring of the water and electricity systems may help public utilities identify disturbances early and promptly restore service, resulting in more effective infrastructure management and operations (Vicky Meek, 2022; Rost, J. C, 1993).

A smart city gets an advantage by giving local government, service providers, and residents interested in enhancing the city's quality of life access to relevant geospatial data, procedures, and analytics on any device. Municipal authorities may better anticipate future developments and monitor changing situations by incorporating this technology into numerous services. Selecting the community responsible for the development of a smart city is one of the most crucial stages in the process. This will enable smart sustainable cities to safeguard the power of new information and technology (Di Stefano, G., Scrima, F., and Parry, E, 2019; Yukl, G, 2006). Determining the community's features is essential to building a smart city (Liao Er Dong, 2023; Nauman, S., Khan, A. M., and Ehsan, N, 2009). Effective management and integration of smart devices also depend on an understanding of the social environment. Successful smart infrastructure requires a systematic investment plan in AI, IoT, and high-performance cloud platforms in order to transition from budgetary constraints to new revenue streams. By incorporating real-time data for smart parking, green transportation, and cross-departmental incident response, cities may optimize mobility and enhance public safety. Furthermore, specialist IoT systems for monitoring energy, water, and air quality—such as indoor CO2 and room management sensors—provide the vital data needed for fair, sustainable urban policy (Soni, A, 2023; Goulet, L. R., and Frank, M. L, 2002). City authorities must eventually work with capable businesses that provide scalable, tailored gateways and sensors in order to manage assets in complex environments and guarantee a high quality of life via reliable, cheap digital ecosystems.

Compared to a city that has a traditional "transactional" relationship with its residents, a smart city could be more capable of handling difficulties. There are several ways to understand the sentence, however (Zhitao Li, 2026). Smart city technology have already been implemented in several places. Initiatives for smart cities have drawn criticism for being corporate-driven (Hossain, K. A, 2023; Vicky Meek, 2022), poorly tailored to local requirements (Watson), mostly ineffectual, and a step toward authoritarian surveillance (Hossain, K. A, 2023). Cybersecurity must play a significant role as cities grow more intelligent and interconnected (Trigyn, 2024). While there are many advantages to IoT and smart cities, there is also a need to protect citizens' privacy, safety, and general well-being (Nele Coghe, 2021). Smart cities can create a secure future where innovation and resilience coexist by implementing preventive measures, enacting strong cybersecurity regulations, and cultivating an awareness-based culture. This will provide an intelligent, reliable, and safe networked urban environment (Liao Er Dong, 2023). The following are potential cybersecurity best practices for IoT, AI, and smart cities:

1) Encryption and Secure Communication: Use strong encryption techniques to protect information sent between networks and devices. This guarantees that the information is kept private even in the event that it is intercepted (Hollands, R. G, 2008).
2) Regular Software Updates and Patch Management: Update IoT systems and devices with the most recent security fixes. Frequent software updates aid in patching security holes that hackers might exploit (Chan).
3) Network Segmentation: To reduce the possible consequences of a security breach, isolate important systems and network parts. By doing this, vital portions of smart city infrastructure are shielded from unwanted access (Komninos).
4) Authentication and Access Control: Put in place robust authentication procedures to confirm users' and devices' identities. Strict access restrictions should be implemented to guarantee that only authorized users can communicate with IoT systems. (Lipman-Blumen, J, 2005).
5) Security by Design: From the beginning of IoT devices and smart city initiatives, integrate cybersecurity measures. Instead of being an add-on, security should be a crucial component of the design and development process (Liao Er Dong, 2023; Peris-Ortiz, Marta; Bennett, Dag R.; Yábar, Diana Pérez-Bustamante, 2016).
6) Incident Response and Recovery Plans: Create thorough incident response plans to quickly handle cybersecurity issues. A clear plan in place speeds up recovery efforts and lessens the impact of a security incident (Talari, Saber; Shafie-khah, Miadreza; Siano, Pierluigi; Loia, Vincenzo; Tommasetti, Aurelio; Catalão, João, 2017).

Public Awareness and Education; Inform stakeholders and the general public on the significance of cybersecurity in smart cities. To enable people to defend themselves and support citywide security, cultivate a culture of cyber awareness (Albino, V., Berardi, U., & Dangelico, R. M, 2015; Lim, Yirang; Edelenbos, Jurian; Gianoli, Alberto, 2019).

In the twenty-first century, technological experts and legal professionals must work together to address significant legal or ethical issues or challenges in the near future. Frequent staff training on cybersecurity and ethical AI usage is

essential for successful deployment, as is close multidisciplinary cooperation between legal and technical specialists. This collaborative approach ensures that innovation is matched with responsibility by fostering a thorough awareness of ethical consequences (Madzar, S, 2001; Patterson, N, 2023). Because of this, regulatory frameworks are always changing to keep up with advances in technology. In order to ensure that the workforce stays flexible and responsive to the quickly evolving needs of smart cities, policymakers in developing countries must now carefully examine creating policies that support lifetime learning and ongoing smart skill development (Joshi, M., Vaidya, A, 2018; Ahmad K., Maabreh M., Ghaly M., Khan K., Qadir J., and Al-Fuqaha A, 2022). Relevant research highlights the significance of digital engagement and smart technology-friendly approaches as a major driver of skill development for all stakeholders, including citizens in smart cities. In order to guarantee that all people, regardless of age or background, have access to the digital and smart resources and training required to thrive in a smart city environment, it is crucial to ensure digital and smart technology inclusion and literacy (Ratten V, 2017). In today's smart city settings, stakeholders must be informed about the creation of successful programs for lifelong learning and smart skill development across a variety of demographics and career phases to build and access specialized policy and educational initiatives (Mahmud M. M. and Wong S. F, 2022).

## 7. Conclusion

Today, the convergence of AI, IoT, and the computing continuum is fundamentally reshaping the global economic fabric and urban landscape. While AI is forecasted to transform up to 375 million jobs by 2030, this shift creates a critical demand for "smart skills"—such as digital literacy and critical thinking—to navigate a complex, interconnected financial ecosystem. However, this rapid progression introduces profound ethical dilemmas; as Warren Buffett noted, the power of AI carries risks comparable to those of nuclear technology, necessitating a firm commitment to accountability, integrity, and transparency to ensure that technology serves a human purpose. Smart cities emerge as a creative solution to rapid urbanization, utilizing ICT to integrate public services, infrastructure, and environmental sustainability across six core domains. To move beyond a mere "technological push" from vendors, these cities must prioritize citizen-centric models that favor open data and resident participation. Smart cities operate through a three-layered framework—a foundation of sensors and high-speed connectivity, an application layer that converts raw data into intelligence, and a social layer for public adoption—all accelerated by the convergence of 5G, IoT, and mobile technology. This digital evolution has shifted healthcare from an individual-focused model to a community-centric "smart health" (s-health) approach, which differs from standard e-health or m-health by utilizing localized, distributed sensors to enhance inhabitant well-being. By analyzing real-time data, such as air quality or allergen levels, s-health systems can proactively guide residents away from environmental hazards and toward personalized care, effectively reducing the strain on traditional medical infrastructure through preventative, data-driven insights.

In future to handle smart cities legal practitioners need to increase awareness and educate themselves on a constant basis. It is essential to keep up with technology developments and comprehend their ramifications. In a technologically advanced society, maintaining competency and ethical standards requires active participation in continuing education and training. It is crucial to create and adopt best practices and ethical standards tailored to smart technologies. In order to create thorough ethical frameworks, professional associations and governing bodies are essential. These frameworks ought to address issues like cybersecurity, privacy, data protection, bias reduction, and ethical social media use that are brought on by smart technology. By leveraging the computing continuum—edge, fog, cloud, and HPC—metropolitan areas can handle data localization and scalability, allowing residents to interact directly with municipal platforms to manage energy consumption, transportation, and waste more efficiently. As the global population shifts toward urban centers, the holistic integration of real-time AI and IoT is essential for ensuring public safety and environmental resilience. Success depends on the ability to transform raw sensor data into actionable insights while maintaining strict data anonymization and cybersecurity. Ultimately, the evolution of smart cities is not just an architectural change but a fundamental shift in the societal fabric, requiring adaptive e-governance and sustainable strategies to meet the needs of future generations and improve the overall quality of life.

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## Biographies

**Rear Admiral Dr. Khandakar Akhter Hossain**, was commissioned into the Engineering Branch of Bangladesh Navy on 01 January 1991. He has completed his BSc. and MSc. Engineering in Naval Architecture and Marine Engineering with a distinct result from Bangladesh University of Engineering and Technology (BUET). He also holds PhD from Bangladesh University of Engineering and Technology (BUET). He has performed various instructional duties in Naval Academy, Marine Academy, NIT and Military Institution of Science and Technology (MIST). He was also the Dean/Head (On NAME department/ME Faculty) at Military Institution of Science and Technology (MIST). He has served as member Engineering in Chittagong Port Authority. He successfully performed the duties of Managing

Director (MD) in all three shipbuilding heavy industries run by Bangladesh Navy, namely Chittagong Dry Dock Limited (CDDL), Dockyard & Engineering Works Ltd (DEW) and Khulna Shipyard Ltd (KSY). He also performed his duties as Area Superintendent Dockyard of Bangladesh Navy. He is a fellow of different prestigious institutes like IEB(BD), RINA(UK), and IAMSP(USA). Before joining here, he performed his duties in the prestigious post of Assistant Chief of Naval Staff (Materiel). He has 236 international publications/papers/books on AI, IoT, Robotics, Satellite Communication, ship recycling, shipbuilding, energy solutions, human resource diversification, port operations, and advanced technologies which all are available in "Google Scholar". He is happily married with Dr. Sharmin Hasan and blessed with twin daughters and two sons.

**Dr. Sharmin Hasan** is an accomplished medical professional, counselor, and healthcare leader with over 20 years of experience in medical practice and patient care. She currently serves as the Vice President (Health, Welfare & Counseling) of the Bangladesh Navy Family Welfare Association, where she has been contributing her leadership and expertise for the past three years in promoting healthcare awareness, welfare initiatives, and counseling services. Dr. Hasan earned her Bachelor of Medicine and Bachelor of Surgery (MBBS) from Bangladesh Medical College in 2002 and has since built a distinguished career in clinical assessment, diagnosis, treatment planning, and patient management. In addition to her medical practice, she has over 12 years of experience in counseling, providing guidance in health and mental well-being. To further strengthen her professional expertise, she completed specialized training in Mental Health Counselling and Behavioral Medicine from China and obtained a Master of Health Care Management from the United Kingdom. With strong leadership, communication, and analytical skills, Dr. Hasan continues to make significant contributions to healthcare and community welfare through her dedicated service and compassionate approach. She is happily married to Rear Admiral Dr Khandakar Akhter Hossain, who is the Vice Chancellor of Bangladesh Maritime University, and is blessed with twin daughters and two sons.