

Research Article

Incorporation of Artificial Intelligence in Enhancing Quality of Life in Smart Cities

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Abstract

Rapid urbanization and low residential resources in cities are serious issues that are making city life difficult day by day. The development of smart cities is becoming a need of the present era due to the swift increase in population and environmental issues globally. Smart cities are being introduced in different regions of the world with the incorporation of latest technologies. The incorporation of Artificial Intelligence (AI) is one of the tools that can be used in smart building and cities. AI technologies are transforming public safety, trash management, healthcare, traffic control, and resource management, making cities more sustainable, effective, and responsive to their citizens' demands. There are still lack of awareness in some areas of the world on the efficacy of smart building and construction that is impacting negatively on the economy and growth of those countries.; such as Pakistan is one of those countries that is facing serious challenges due to increased population, urban migration, and poor management of natural resources. The need of planning smart strategies for smart building is very crucial to manage population and housing issues. Smart buildings and cities provide unique and convenient facilities to its residents so that they can contribute positively towards the economy of country. This paper focuses at important areas where AI has the most effects in order to investigate how integrating AI improves quality of life in smart cities. The aim is to highlight artificial intelligence's contribution to improving urban operations, streamlining resource management, and advancing sustainability. Additionally, potential concerns about privacy, data security, and fair access will be discussed. In order to show how AI-driven innovations like predictive analytics, machine learning, and IoT-enabled systems are changing the urban environment, the study synthesizes existing research and real-world examples. The evaluation also covers how AI promotes smart government, tailored urban services, and citizen involvement. The conclusion emphasizes that although AI has great potential to improve the quality of life in smart cities, implementation of the technology must be done in a balanced way to prioritize inclusive policies and ethical concerns for the general welfare of residents.

Keywords

Artificial Intelligence, Quality of Life, Smart Cities, Technologies

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1. Introduction

The world's top research and advisory firm, Gartner, claims that the idea of a "smart city" creates comprehensive solutions for urban ecosystems by using data gathered from various electronic Internet of Things (IoT) sources [4]. In order to effectively manage urban flows through real-time responses, information about buildings, people, devices, and assets is processed for this purpose. The phrase "smart city" is defined by the great majority of literature as applications and technologies that meet the following three criteria: Cities and communities are the target group, information and communication technologies (ICT) are being used, living and work-

ing conditions are being enhanced in the area [18].

In order to integrate cutting-edge hardware and software based on information and communication technology (ICT) into urban planning, the concept of the "smart city" was originally presented in 1990. A smart city uses information and communication technology (ICT) to improve the standard of living for its residents, promote economic growth, make it easier to manage transport and traffic issues, maintain a clean and sustainable environment, and enable easy access to government authorities [1].

1.1. Dimensions of Smart Cities

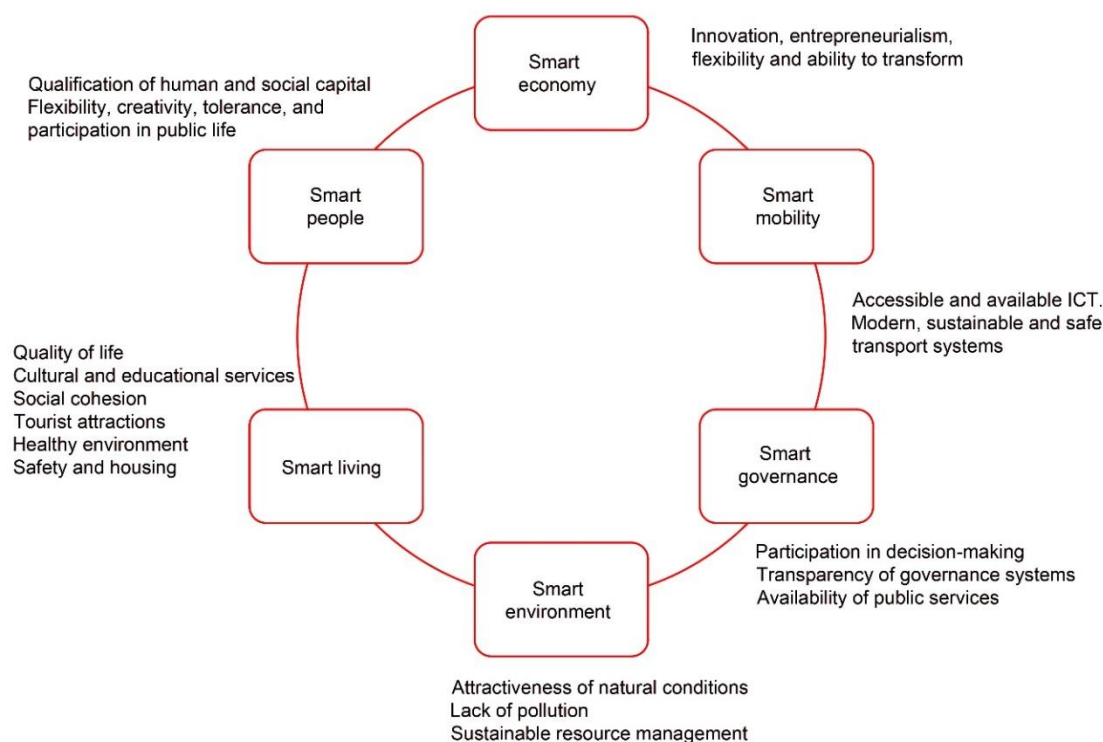


Figure 1. Dimensions of Smart Cities. Source [12].

The diagram is taken from a previous study on the topic of "developing smart city services by mobile application" done by Kunttu in 2019. The diagram has been selected due to its detailed description. This diagram depicts the concept of smart cities at its best by showing its dimensions.

1) *Smart People*: Smart individuals seeking socially and sustainably sustainable life are the foundation of smart cities. Reduced use of non-renewable resources, envi-

ronmental preservation, a healthy and diverse economy, autonomous communities, community autonomy, citizen well-being, and the fulfillment of fundamental human needs are all considered aspects of sustainability [10].

2) *Smart Governance*: Another crucial component of a smart city is its governance, which calls for efficient cooperation between the state, stakeholders, people, and

socio-technical systems. Complex policies, procedures, and a framework are necessary for governance [19]. In order to ensure sustainable urban development, one task of urban governance could be understood as the management of urban issues (including databases, characteristics, and their own relationships) and the creation of intelligent cooperation between these individual sectors and the various agencies responsible for overseeing them, as well as the various urban actors on the market [20].

- 3) *Smart Economy*: The new economic phenomena are found in the smart economy. With the advent of new forms of economic relations, the long-standing standard framework breaks down. The smart economy leverages IT solutions to achieve efficiency and detect issues; it makes judgments, allocates resources effectively, and facilitates collaboration across disciplines using the data gathered [16]. The idea of a smart future built on environmental preservation, sustainability, advanced scientific research, and creative process optimization incorporates innovations and inventive activities. Smart economy is one of the critical features of smart cities, as it consumes technology to facilitate its citizens in cost efficient ways.
- 4) *Smart Living*: For certain residents, smart living which is founded on immersive information and data and is propelled by people, services, and communities using intelligent networking is not an easy concept. The intelligent lifestyle made possible by smart technology is not the only definition of smart living in this critical evaluation; rather, focus is placed on the enhanced quality of life that results from the autonomous use of smart technology in environmentally responsible settings [7]. Innovative use and application of technologies make cities smart and motivate individuals to experience a better way of living.
- 5) *Smart Mobility*: By offering effective and sustainable transportation options that satisfy the demands of both

locals and tourists while managing traffic, boosting air quality, and improving quality of life, smart mobility plays a critical role in smart cities. Using technology and data, smart mobility solutions maximize the utilization of transportation resources and infrastructure. Promoting sustainable means of transportation including; walking, bicycling, and public transportation while minimizing reliance on single-occupancy vehicles is one of the main objectives of smart mobility in smart cities [24].

- 6) *Smart Environment*: Three main environmental contamination issues that really cause problems are air quality, water pollution, and radiation pollution. Sufficient oversight is required to ensure that a healthy society and sustainable global growth are maintained. The advancements in technology and the creation of contemporary sensors has shifted environment monitoring into a smart environment monitoring (SEM) system in recent years that is a unique part of smart cities [23].

1.2. Incorporation of Artificial Intelligence in Smart Cities

Artificial intelligence is the process of teaching computers to emulate human thought processes and behavior. In addition, it is a subfield of computer science that focuses on modeling human cognitive functions and data-driven systems, which allow a computer or software to do tasks or reach conclusions.

AI-based smart applications are currently the main focus of smart city programs in major nations. Statistics from the 2018 New York Smart Schools Commission Report indicate that by 2025, the AI market would be valued \$190 billion [8]. AI has been applied in smart city research and applications recently, and scholars have noted that AI is playing a bigger role in smart urbanism. AI, by merging modern machine vision, NLP, ML, robotics, and other technologies with enormous resource pools, may boost productivity and enhance the quality of life for the smart cities of the future [22].

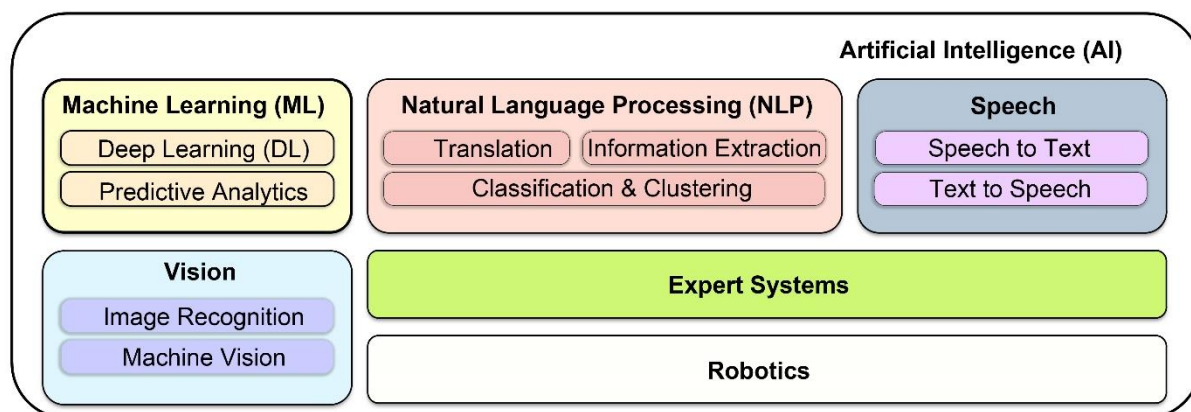


Figure 2. Six AI Technologies Used in Smart Cities. Source [8].

Smart city Machine learning (ML), natural language processing (NLP), speech, vision, expert systems, and robotics are the different subcategories of artificial intelligence technology.

Smart grids (SGs), intelligent transportation, cyber-security, UAV-assisted next-generation communication (5G and B5G), etc. are just a few of the industries that are heavily involved in smart city projects. Big data analytics and the appropriate application of AI, ML, and DRL-based approaches can improve the effectiveness and adaptability of all the previous sectors of a smart city project. The development of machine learning (ML) and deep learning (DRL) techniques has greatly impacted the modern intelligent transportation system (ITS), enabling self-driving cars, connected vehicle security, effective passenger search, and secure travel [21].

Artificial intelligence, machine learning, and deep learning techniques have a remarkable impact on cyber-security, affecting nearly every industry inside a smart city. An Intrusion Detection System (IDS) is frequently built to provide continuous monitoring and detection of cyber attacks throughout the network lifetime in order to supplement this security protocol provision [17].

Cities are experimenting with a variety of governance models in an increasingly digitized and urbanized environment. These models are guided by decision support systems that use (near) real-time information, including social media sources, to improve sustainability and resilience [9].

Smart city applications like smart communities, smart industries, smart healthcare, smart education, and smart development heavily rely on natural language processing (NLP). Better healthcare facilities are provided in smart cities by harnessing the data from digital health records for clinical research using natural language processing (NLP) to identify potential patients, premedicate diseases, forecast surgical problems, and much more [2].

Additionally, NLP is being used to modernize a range of industrial and corporate processes. It particularly assists with business document analysis and market trend prediction [11].

Detecting hate speech, creating headlines, smart requirement engineering, and legal outcome prediction are a few more diverse NLP application areas in smart cities [6].

As a result, it is clear that NLP is playing a more and bigger role in the technological toolkit that smart cities are using to address contemporary issues and give their residents greater facilities.

1.3. Quality of Life in Smart Cities

The concept of a "smart city" serves as a catalyst for the creation of laws that enhance society and, in turn, the standard of living for its people. The combination of human capital, social capital, and information with the use of communication technological infrastructure is the foundation of smart cities, according to literature, and it is intended to promote economic

development as well as enhance people's quality of life and well-being [5].

Quality of life is therefore essential to the creation of smart cities. Since smart cities are a relatively new concept, there are a number of research gaps about the variables affecting life quality. This gap is being addressed by the present study by evaluating the impact of Artificial intelligence in enhancing quality of life of people residing in smart cities.

2. Research Methodology

The objective of the study is to examine the efficacy of Artificial Intelligence on quality of life in smart cities. The author could not find relevant material, researches and articles from Pakistan, so different studies were picked from around the globe by using multiple databases.

The data was gathered through published papers and articles from journals in the field of architecture, and Artificial Intelligence. The articles, papers and previous studies were searched on mdpi, emerald insight, science direct, and research gate database. Relevant material was searched by using keywords; "smart cities", "artificial intelligence", "quality of life" etc. These studies belonged to different Asian, and European countries who have been very much interested in developing smart cities in their region to enhance their economy and productivity. These studies were chosen on the basis of their published years, language, and relevance to study objectives. Researches before 2020 were excluded and all updated studies from 2020 to 2024 were selected to refine the results. Only English language studies were selected to develop a better understanding of the topic. Total 54 studies were gathered initially but after selection criteria, only 23 were left which were carefully read and incorporated into our study. Mostly, data was extracted from the key findings of the studies that demonstrated that how artificial intelligence can make smart cities more smart and raise quality of life of residents living there.

3. Discussion and Analysis

Gaining a deeper understanding of the domains and indicators that are used to assess and investigate quality of life in smart cities was one of the key goals of conducting a review study. It is evident that quality of life is a multifaceted and intricate area of research that necessitates the integration of several domains, including both objective and subjective markers.

According to research conducted in South Korea on the most important aspects of smart cities, the three most crucial subjects found to be culture, the environment, and transportation. The findings from three Korean cities show that local surroundings, convenience, and safety are all seen as benefits of smart city living [15]. Researchers found that when Taiwanese cities were compared, residents' top concerns were

about smart environments, smart healthcare, smart transportation, and smart safety [10]. According to one study, the four most crucial pillars are people's participation in creating an informed, intelligent society; they are followed by sustainable energy management, environmental preservation, mobility and transportation, and sustainable economic development [3]. Living circumstances in urban areas, public safety, education, and housing were shown to be the top four factors in Poland that have the most effects on quality of life [14]. The best way to improve the quality of smart living in Iran is believed through the use of smart devices and cutting-edge, contemporary techniques for promoting social health and hygiene. Within the safety domain, cybersecurity has been identified as one of the major perceived hazards in urban areas.

Based on multiple studies, it appears that quality of life is heavily influenced by the priorities and context. If smart cities push technical solutions without considering the unique characteristics of the region and its residents, they will fail to meet their goals. It was said that as every city is different, public engagement tactics had to be customized and adjusted for each setting [13].

After making a comparison between precious studies, the present study is able to demonstrate that how Artificial Intelligence can enhance quality of life of people in smart cities.

In smart cities, artificial intelligence (AI) contributes significantly to improving human wellbeing in a number of ways.

- 1) *Efficient management of resources*: AI systems can optimize the use of resources like energy, water, and transportation, which can cut expenses and waste. For example, traffic flow can be managed by AI-powered systems to reduce traffic and air pollution, which benefits locals by reducing stress and providing cleaner air.
- 2) *Safety and protection*: Artificial intelligence (AI)-powered surveillance systems are able to instantly identify anomalies or possible dangers by analyzing massive amounts of data from several cameras, sensors, and other sources. This improves public safety by enabling emergency services to respond more quickly.
- 3) *Effective healthcare system*: Applications of AI in healthcare can enhance patient care, individualized treatment regimens, and diagnostics. Healthcare systems driven by artificial intelligence (AI) in smart cities are able to analyze data from wearable, electronic health records, and public health databases in order to spot health patterns, identify outbreaks early, and provide citizens proactive care.
- 4) *Adequate Infrastructure Planning and Development*: In order to assist city planners in making defensible choices about land use, public transit, and infrastructure development, artificial intelligence (AI) can analyze urban data and spot patterns and trends. Urban landscapes that are more sustainable and habitable may be protected by this planning.
- 5) *Accessibility*: By interpreting audio or signage, im-

proving communication with public services, and offering real-time navigation aid, AI-powered solutions can increase accessibility for people with disabilities.

- 6) *Comfort and Convenience*: Artificial intelligence (AI)-powered smart home solutions can improve residents' comfort, convenience, and security by automating repetitive operations, maximizing energy efficiency, and identifying and addressing possible threats.
- 7) *Environmental Safety*: Cities that want to monitor and control environmental aspects like waste management, renewable energy production, and the quality of their air and water can benefit from AI. Artificial Intelligence enhances the quality of life for inhabitants and promotes a healthier environment by minimizing pollution and optimizing resource utilization.
- 8) *Economic Growth*: By establishing companies, encouraging entrepreneurship, and generating job opportunities in developing industries like AI research and development, data analytics, and smart infrastructure, AI-driven innovation can boost economic growth.
- 9) All things considered, artificial intelligence (AI) significantly contributes to improving accessibility, efficiency, safety, healthcare, environmental sustainability, and economic development in smart cities. However, in order to prevent escalating already-existing disparities and protect privacy rights, it is crucial to make sure that AI deployment in smart cities is driven by the concepts of justice, transparency, and accountability.

Guidelines for Incorporating AI in Upcoming Smart Cities

The quality of life for citizens of smart cities can be greatly improved by integrating artificial intelligence (AI). When incorporating AI into projects aimed at creating smart cities, keep the following in mind:

- 1) *Determine the Main Obstacles*: Recognize the unique issues that your city faces, such as trash management, energy use, traffic congestion, and public safety. AI can be used to more successfully handle these issues.
- 2) *Data Integration and Collection*: Gather pertinent information from a range of sources, such as sensors, cameras, and Internet of Things devices. Make certain that a centralized platform for AI analysis incorporates this data.
- 3) *Algorithms for Machine Learning*: Apply these algorithms to analyze the gathered data and get relevant insights. Making data-driven decisions, maximizing resource allocation, and forecasting trends can all be aided by these insights.
- 4) *Predictive Analytics*: Make use of artificial intelligence to predict future trends and events. Predictive maintenance, for instance, can assist in preventing malfunctions and minimizing downtime in infrastructure.
- 5) *Traffic Management*: To improve traffic flow, lessen congestion, and cut down on travel times, use AI-powered traffic management solutions. Intelligent routing algorithms, adaptive traffic signal regulation,

and real-time traffic monitoring are a few examples of this.

- 6) *Energy Efficiency*: To maximise the use of energy in buildings, street lighting, and other infrastructure, apply artificial intelligence. AI can automatically alter settings to minimise waste and lower costs by analysing patterns in energy usage.
- 7) *AI-based solutions for public safety and security*: such as facial recognition video surveillance, predictive policing, and emergency response optimization, should be implemented.
- 8) *Public Engagement*: To guarantee accountability and transparency, include the public in the development and execution of AI-powered projects. Use chat bots and virtual assistants driven by AI to elicit comments and deliver inhabitants information.
- 9) *Security and Ethics*: When applying AI to smart city projects, give data privacy and ethical issues top priority. Make sure laws like the GDPR are followed, and provide precise rules for the use and security of data.
- 10) *Scalability*: Design AI systems with scalability in mind to support future expansion and integration with additional smart city technologies. This would guarantee smooth cooperation and communication between various departments and systems.
- 11) *Continuous Monitoring and Assessment*: Keep a close eye on how AI-powered systems are doing and assess their effects on quality of life metrics like sustainability, mobility, safety, and air quality on a regular basis. Over time, make adjustments based on this feedback to increase the efficacy of smart city projects.

Cities can use artificial intelligence to make their urban environments more resilient, sustainable, and habitable for their citizens by adhering to these standards.

4. Conclusion

By analyzing the literature, the review determines the dimensions. It should be noted that not all instances of smart cities use every dimension; instead, they take into account how some dimensions may have a significant impact on their goals. The research also shows that there are differences in the degree of technological applications. The usage of ICT and related technologies has increased risk, particularly in the areas of safety, privacy, and security. The review also demonstrates the hazards that smart cities confront, both non-technical and technical. The evolution of technology and procedures causes a shift over time in the degree of risks and complexity of their management. Consequently, it becomes critical to continuously monitor and assess the risks associated with each of the smart city's dimensions as well as the system as a whole.

This research can facilitate government authorities, builders and smart city owners to understand the best utilization of artificial intelligence to enhance quality of life of people. However, they need to assess residents' needs first and plan

strategies to fulfill those needs by promoting latest technologies of AI.

Abbreviations

AI	Artificial Intelligence
IoT	Internet of Things
ICT	Information and Communication Technologies
IT	Information Technology
SEM	Smart Environment Monitoring
NLP	Natural Language Processing
ML	Machine Learning
SGs	Smart Grids
DRL	Deep Learning
ITS	Intelligent Transportation System
IDS	Intrusion Detection System

Author Contributions

Aman Ullah: Conceptualization, Data curation, Investigation, Methodology, Supervision, Validation, Writing—original draft

Syeda Arfa Quddusi: Data curation, Methodology, Supervision, Writing—review & editing

Iftikhar Haider: Data curation, Methodology, Project administration, Writing—review & editing

Conflicts of Interest

The authors declare no conflicts of interest.

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