

## A LITERATURE REVIEW ON ARTIFICIAL INTELLIGENCE IN SMART CITIES

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### **Background of the study:**

In today's urban development, artificial intelligence (AI) has become a disruptive force. Applications for it are found across a wide range of fields, including public safety, energy optimisation, traffic management, and citizen involvement. Artificial Intelligence (AI) is a driving force behind smart city initiatives that aim to improve urban people' quality of life, infrastructure, and resource efficiency. The transport sector is one of the most well-known uses of AI in smart cities. AI-driven traffic control systems have the ability to adjust instantly to changing traffic circumstances, minimising gridlock and cutting down on commuting times. Routes and schedules for public transit are further optimised by intelligent transportation systems, enabling effective and sustainable urban travel. AI is essential to energy management even outside the transportation sector. AI systems can estimate future demand, find inefficiencies, and optimise patterns of energy consumption by processing data from a variety of sources. This guarantees a consistent and reasonably priced energy supply while helping smart cities to lessen their carbon footprint. Monitoring systems with AI capabilities improve crime detection and avoidance in the field of safety for everyone. Suspects can be identified with the help of facial recognition technology, and abnormalities suggestive of possible threats can be found by AI algorithms analysing sensor data. AI also helps speed up emergency responses by evaluating traffic patterns and figuring out the best routes for responding cars. In smart cities, AI also transforms citizen engagement. While virtual assistants driven by artificial intelligence (AI) offer individualised support and control over smart home gadgets, smart city platforms give inhabitants access to real-time data on offerings, facilities, and events. This fosters a more connected and convenient urban environment, enhancing the overall user experience.

### **AI's advantages in smart cities:**

AI have the potential to greatly assist disadvantaged communities of all ages when used wisely. Improving public safety is one prominent application.

- **Predictive Policing:** AI can detect high-risk regions and more efficiently deploy resources by evaluating crime data, thereby averting crimes before they happen.
- **Video Surveillance:** AI-enabled video analytics can support public safety by quickly notifying authorities of questionable activity.
- **Emergency Response:** By evaluating data from several sources, AI can optimise the distribution of resources and emergency response routes in emergencies or natural calamities.
- **Personalized City Services:** Chatbots powered by artificial intelligence and digital assistants can expedite citizen-local government interactions while giving locals 24/7 availability of information and services.

#### **Smart Cities' AI's Social The implications:**

A significant social impact could result from the incorporation of AI in smart cities. Although artificial intelligence has many benefits, there are also significant moral and practical issues to be addressed.

- **Better Quality of Life:** By streamlining logistics, electricity, and healthcare services, artificial intelligence (AI) can improve quality of life in smart cities.
- **Improved Safety:** By identifying and stopping criminal activity, AI-driven surveillance systems can improve public safety.
- **Sustainable Development:** By saving resources and lessening its negative effects on the environment, AI can help promote sustainable development.
- **Economic Growth:** AI-powered advancements have the potential to introduce new markets, employment sectors, and business ventures.
- **Improved Civic Participation:** Artificial Intelligence can help promote civic engagement and involvement in local government.

**Digitization in Smart Cities: A Ethical and Sustainable Approach:** Smart cities have emerged as a result of the rapid growth of technology. However, there are drawbacks to the digitisation of cities, such as potential social inequality, data security problems, and privacy concerns. The following guidelines must to be taken into account in order to guarantee sustainable and responsible development:

• **Data protection and Privacy:** Regarding the acquisition, use, and access to data, cities ought to be open and honest. People ought to give informed consent and have authority over their personal data. To safeguard data against vulnerabilities and unauthorised entry, adequate safety precautions have to be put in place.

### **AI for Cities with Smart Environment Management:**

In smart cities, artificial intelligence (AI) is a potent tool for solving environmental issues. Through extensive data analysis and pattern recognition, cities may make well-informed decisions aimed at enhancing sustainability and mitigating their environmental effect.

### **Key applications of AI in environmental management include:**

- **Waste Management:** AI is capable of predicting the generation of waste, finding recycling options, and optimizing waste collection routes. Waste sorting can be automated using computer vision algorithms, increasing recycling rates and decreasing landfill waste.
- **Air Quality Monitoring:** AI-driven sensors are able to track and identify pollutants in the air. Cities can use this data to analyse pollution hotspots, put mitigation plans in place, and notify the public about the state of the air quality.
- **Energy Efficiency:** AI systems are capable of analysing trends in energy usage and pinpointing areas in need of development. Artificial intelligence (AI) enables smart grids to better integrate renewable energy sources, minimize peak demand, and optimise energy distribution.
- **Water Resource Treatment:** AI may help in estimating water demand, streamlining water distribution systems, and identifying leaks or problems with the quality of the water. Water quality criteria can be monitored by AI-powered sensors, guaranteeing a safe and drinkable supply of water.
- **Urban Planning:** By examining patterns of land use, growth in population, and transportation systems, AI can help with urban planning. This information can be used to lessen environmental effects and find chances for sustainable development.

In smart cities, artificial intelligence (AI) for environmental management can lead to cost savings, increased long-term viability data-driven decision-making, and increased efficiency. Smart cities may grow more resilient, sustainable, and livable for future generations by utilizing AI.

**Objective of the study:****➤ To review the role of artificial intelligence in smart city:**

To promote egalitarian, productive, and sustainable smart cities. Along with examining the particular benefits and Future Directions that come with it, this analysis will examine AI's uses in a variety of cities, such as public safety, energy management, transportation, and citizen involvement.

**Literature Review:**

**Behera, N.R., (2023)** Conducted study on Use of Artificial Intelligence in Smart City Development. This research explores the potential of artificial intelligence (AI) to revolutionize transportation and urban living. It emphasizes the importance of human-centered AI development that focuses on understanding and fulfilling user needs. The research discusses the intersection of AI, transportation, smart cities, and their implications for urban futures. It highlights innovative mobility solutions such as Connected and Autonomous Vehicles (CAVs), Individual and Autonomous Flying Vehicles (IAFV), and technologies like the Internet of Things (IoT) and Industry 4.0. The research provides a unique perspective on the convergence of these elements and their potential to shape urban landscapes.

**Alahi, Md Eshrat, (2023)** Conducted study on Integration of IoT-Enabled Technologies and Artificial Intelligence (AI) for Smart City Scenario: Recent Advancements and Future Trends. This research explores the role of IoT and AI in creating smart cities. It defines smart cities and discusses the architecture of IoT. The research analyzes different wireless communication technologies used in smart cities, identifying the most suitable options for various applications. It also examines AI algorithms and their suitability for smart city use cases. The integration of IoT and AI, particularly with 5G networks, is discussed, highlighting its potential to advance urban environments. The research contributes to the existing literature by emphasizing the opportunities presented by IoT and AI in building sustainable and livable smart cities.

**Selvaraj, R., Kuthadi (2023)**, Conducted study on Smart building energy management and monitoring system based on artificial intelligence in smart city. Sustainable Energy Technologies and Assessments. This research proposes an AI-based system (AIMS-SB) to address energy management challenges in smart buildings. AIMS-SB aims to predict energy analysis, renewable energy production, and recycling evaluation. It develops eco-design monitoring systems to optimize energy consumption, utilization, and drain characteristics. AIMS-SB offers viable solutions to smart city energy management challenges, improving

safety, recycling, and energy resource reuse. The system's findings demonstrate increased accuracy and efficiency compared to traditional methods.

**Moumen, I., (2023)** Conducted study on enhancing urban mobility: integration of IoT road traffic data and artificial intelligence in smart city environment. Indonesian Journal of Electrical Engineering and Computer Science. This paper proposes an AI framework to optimize traffic flow in smart cities using IoT road traffic data. It collects real-time traffic data with IoT sensors, processes it using machine learning and deep learning algorithms, and develops accurate traffic forecasting models. The framework outperforms existing approaches, offering a widely applicable solution for smart city traffic management. By leveraging IoT and AI, real-time monitoring, proactive decision-making, and dynamic traffic control can be achieved, leading to improved traffic flow and urban mobility. This research provides valuable insights into the potential of IoT and AI in addressing urban traffic challenges and lays the foundation for intelligent transportation systems in smart cities.

**Szpilko, D., (2023)** Conducted study on Artificial Intelligence in the Smart City — A Literature Review. This article explores the impact of AI on smart cities, focusing on data security and privacy challenges due to IoT. It conducts a systematic literature review to classify research on AI in smart cities and identify future research directions. The analysis identifies seven research areas: safety, living, energy, mobility, health, pollution, and industry. The article highlights innovations in urban mobility through AI applications but emphasizes the need for further research in security. It also discusses AI's role in energy management and sustainability, requiring standardized regulations for renewable energy adoption. Additionally, AI's applications in health, environment, and industry require further investigation to address data handling, privacy, security, and societal implications. Overall, the article emphasizes the need for responsible and sustainable digitization in smart cities.

**Luusua, A., Ylipulli, J., (2022)** Conducted study on Urban AI: understanding the emerging role of artificial intelligence in smart cities. This article explores the concept of urban AI, which refers to the integration of AI systems into urban environments. It discusses the development of urban AI, its presence in various urban spaces and technologies, and its impact on urban experiences and governance. The article emphasizes the interdisciplinary nature of urban AI, which involves studying the relationship between AI systems and urban contexts. It concludes by highlighting how urban AI orchestrates cities and regions, permeating homes, workplaces, public spaces, and travel experiences, transforming them into hybrid digital landscapes.

**Arrohman, Z.D. (2022)** Conducted study on Application of Artificial Intelligence In Smart City Development. This article explores the application of AI in smart city development within

the context of Industry and Society. AI's ability to connect devices and interpret conditions is highlighted. The study uses a qualitative approach and literature review to analyze the application of the Society. concept to the smart social component. The results provide several explanations for the use of AI in smart city development. Overall, the article aims to describe the challenges and opportunities of applying AI in smart cities.

**Bokhari, S.A., & Myeong, S. (2022)** Conducted study on Use of Artificial Intelligence in Smart Cities for Smart Decision-Making: A Social Innovation Perspective. Sustainability. This study investigates the relationship between AI, social innovation, and smart decision-making. Using survey data from South Korea and Pakistan, the study found a strong positive mediating effect of social innovation on the relationship between AI and smart decision-making. The findings suggest that social innovation plays a crucial role in enabling AI to contribute to effective decision-making, benefiting society and relevant stakeholders.

**Herath, H., & Mittal, M. (2022)** Conducted study on Adoption of artificial intelligence in smart cities: A comprehensive review. This paper explores the use of AI in smart cities. It analyzes 133 articles published between 2014 and 2021 in various domains, including healthcare, education, environment, agriculture, mobility, risk management, and security. The study found that healthcare, mobility, privacy and security, and energy sectors have a significant influence on AI adoption. Since the COVID-19 pandemic, AI adoption in healthcare has increased by 60%. The analysis also identified AI algorithms such as ANN, RNN/LSTM, CNN/R-CNN, DNN, and SVM/LS-SVM as having a higher impact on different smart city domains.

**Barms (2022)** Conducted study on Artificial Intelligence in Smart City Applications: An overview. This article presents a survey of AI-based solutions in smart city implementation. It finds that AI has been adopted in various components of smart cities worldwide, with town planning, governance, and education being less explored. Network-based models, including deep learning, are the most popular AI approaches. The article concludes that AI is an indispensable part of smart cities, both now and in the future.

**Luckey, D., Fritz, (2021)** Conducted study on Artificial intelligence techniques for smart city applications. This paper explores the use of AI in smart monitoring, which involves collecting, analyzing, and communicating structural data from smart infrastructure. It highlights the potential of AI to process large amounts of data and detect patterns that traditional methods might miss. However, the "black-box" nature of AI algorithms can hinder their adoption due to mistrust from engineers. The paper emphasizes the need for explainable AI (XAI) to build confidence in AI for smart monitoring. It categorizes ML algorithms used for smart monitoring



based on their objectives, providing an overview of potential categories that can be modified to achieve explainable AI in civil engineering.

**Ullah, Z., Al-Turjman, (2020)** Applications of artificial intelligence and machine learning in smart cities. This article explores the role of AI, ML, and DRL in smart cities. It focuses on their applications in ITS, cybersecurity, energy efficiency, UAVs, 5G/B5G, and healthcare. The article aims to identify how these techniques can be used to design optimal policies for various smart city challenges. It highlights the potential of AI, ML, and DRL in realizing the concept of a smart city and discusses future research directions in these areas.

**Yigitcanlar, T., (2020)** Conducted Study on Contributions and risks of artificial intelligence (AI) in building smarter cities: Insights from a systematic review of the literature. This article explores the sustainability of AI in smart cities. It reviews the current status of AI and smart city literature and discusses the increasing adoption of AI in urban services. The article examines the potential symbiosis between AI and sustainable urbanism, highlighting the need for informed decision-making about AI adoption in cities. It aims to contribute to academic debates and help policymakers, planners, and citizens make sustainable choices regarding AI in urban environments.

**Golubchikov, Oleg & Thornbush, Mary. (2020)** Conducted study on Artificial Intelligence and Robotics in Smart City Strategies and Planned Smart Development. Smart Cities. This study examines smart city strategies to identify plans for AI and robotics deployment. It analyzes 12 case studies from cities worldwide, finding more concentrated AI and robotics use in the Global North but increasing presence in the Global South. Cities like Moscow have detailed plans for AI and robotics integration. The study discusses the implications of these plans, including cyber-physical systems and social-ethical considerations.

**Cugurullo, F. (2020)** Conducted study on Urban artificial intelligence: From automation to autonomy in the smart city. This paper explores the intersection of AI and smart cities, focusing on the transition from automation to autonomy. It introduces the concept of "urban artificial intelligence" to understand AI in urban contexts. The paper examines Masdar City as a case study of this transition, highlighting the role of technological development and politico-economic agendas. It proposes a research agenda to investigate the autonomous city, which is emerging as AI takes over urban management.

**Singh, S., (2020)** Conducted study on Convergence of blockchain and artificial intelligence in IoT network for the sustainable smart city. Sustainable Cities and Society. This paper explores the convergence of blockchain and AI in creating sustainable smart cities. It discusses the challenges and opportunities presented by blockchain technology in areas like risk

management, finance, IoT, and public services. The paper reviews existing literature on blockchain security issues in smart cities and presents key factors for successful blockchain-AI integration. It summarizes blockchain security enhancement solutions and discusses open issues and future research directions for building a sustainable smart city ecosystem.

**Allam, Zaheer, and Zaynah A. Dhunny.(2019)** Conducted study on "On big data, artificial intelligence and smart cities. This paper explores the potential of AI and Big Data in smart cities, focusing on their role in enhancing urban livability, sustainability, and economic growth. It proposes a new framework that integrates AI technology with key dimensions of culture, metabolism, and governance to ensure successful smart city implementation. The paper targets policymakers, data scientists, and engineers who aim to increase the livability of urban environments through AI and Big Data integration.

**Navarathna, P.J., & Malagi, V.P. (2018)** Conducted study on Artificial Intelligence in Smart City Analysis. This paper explores the role of AI in sustainable smart city development. It highlights how AI technologies can transform cities by improving living standards through digitalization. The paper discusses various AI applications for addressing issues related to city infrastructure, public safety, and security. It emphasizes the importance of integrating IoT, deep learning, machine learning, pattern recognition, Big Data Analytics, and Cloud Infrastructures in building fully functional smart cities.

**Guo, K., Lu, Y., Gao, H., & Cao, R. (2018)** Conducted study on Artificial intelligence-based semantic internet of things in a user-centric smart city. This paper proposes a novel AI-SIoT hybrid service architecture to address the challenges of integrating heterogeneous IoT devices in smart cities. The AI-SIoT architecture leverages semantic and AI technologies to enable flexible connections and efficient data analysis for intelligent service provision. The paper presents practical use cases and discusses the opportunities and challenges of implementing AI-SIoT in future smart cities.

**Khan, S., Paul, D., (2018)** Conducted study on Artificial intelligence framework for smart city microgrids: State of the art, challenges, and opportunities. This article explores the potential of microgrids as a core component of smart cities. It examines factors driving microgrid adoption, benefits, and challenges hindering their widespread use. The article proposes using Artificial Intelligence (AI) to overcome these challenges. A simulation framework and data sources are discussed to support AI development for utilities. The Bluewave-ai framework, leveraging deep learning, is introduced for data center applications. Finally, the article examines AI inference at edge computing nodes and IoT sensors to optimize microgrid benefits at various levels.



### Methodology:

The present investigation utilised a descriptive research design to examine the function of artificial intelligence (AI) in the advancement of smart city development. A thorough analysis of the body of current research was done in order to accomplish this. Academic publications, such as peer-reviewed journal articles, conference papers, book chapters, and dissertations, served as the main source of information. The review was restricted to works released between 2018 and 2023 in order to guarantee the timely and relevant nature of the data. This timeline made it possible to incorporate new developments and trends in artificial intelligence and smart city applications. The qualitative information taken out of the chosen publications was analysed using a content analysis method. In order to find important themes, patterns, and ideas on AI's function in smart cities, it was necessary to methodically go over the content of various sources. By analysing the qualitative aspects of the literature, this study aimed to provide a nuanced understanding of the subject matter.

**Findings drawn from the Literature review on Artificial Intelligence in Smart Cities:** Key Concepts and Findings from the Review of Literature on the Use of AI in Smart Cities Upon reviewing the numerous studies, a number of important themes about the application of AI in smart cities surfaced:

- **AI's Transformative Potential:** AI has the ability to completely transform smart cities, as consistently demonstrated by the analysed studies. Applications include public safety, energy management, transportation, and citizen participation.
- **AI with a human centre:** The significance of creating AI systems that put human needs and ideals first is a recurrent issue. The ethical and successful integration of AI into urban areas depends on an emphasis on human-centred design.
- **IoT and AI Synergy:** The rise of smart cities depends on the integration of IoT and AI. AI can examine the massive volumes of data generated by IoT devices to improve urban services and procedures.
- **Data-Driven Choices:** AI facilitates data-driven choices in a number of smart city administration domains by processing and analysing massive datasets. This gives local government representatives the authority to decide wisely and carry out sensible policies.
- **Opportunities and Difficulties:** Although artificial intelligence (AI) has many benefits, it also has drawbacks, including concerns about confidentiality of information, security, and ethics. In order to guarantee AI's ethical and sustainable implementation in smart cities, it is imperative that these issues be fixed.

### Particular Uses and Benefits:

- **Transit:** Artificial Intelligence is being applied to enhance traffic management, enhance public transit, and promote the advancement of self-driving cars.
- **Energy Management:** AI can more efficiently integrate renewable energy sources, forecast demand, and optimize energy consumption.
- **Public Security:** By identifying and averting criminal activity, AI-powered surveillance equipment can improve the safety of everyone.
- **Civic involvement:** AI can enhance civic involvement through real-time information availability, personalized services, and connection with local governments.
- **Future Directions:**
- **Ethical Considerations:** To tackle the ethical consequences of artificial intelligence (AI) in smart cities, such as concerns related to privacy, accountability, and bias, more research is required.
- **Standardization:** To promote interoperability and scalability, standardised platforms for AI use in smart cities should be developed.
- **Public Participation:** Creating equitable and inclusive smart cities requires ensuring significant public involvement in the creation and application of AI-powered solutions.
- **Long-Term Effects:** Understanding AI's overall advantages and difficulties in smart cities requires evaluating the technologies over time societal, financial, and environmental impacts.

The examined literature indicates that artificial intelligence (AI) has the ability to significantly change smart city design. But achieving this potential will need striking a delicate balance between ethical issues and technological advancement.

#### **Discussion and Conclusion:**

The creation of smart cities that are equal, productive, and durable has made artificial intelligence (AI) a crucial factor. The literature that was analysed in the current investigation demonstrates how AI has the ability to revolutionize a number of industries, notably security, energy management, travel, and citizen involvement. Even if artificial intelligence (AI) has a lot to offer, there are several issues that must be resolved, like privacy of information, security, and ethical issues. Cities may leverage artificial intelligence (AI) to improve quality of life, boost sustainability, and create inclusive urban settings by implementing a human-centred strategy and assuring ethical AI development.

**Key takeaways from the research include:**

- AI's essential role in streamlining urban facilities and procedures. Artificial intelligence (AI) has the potential to improve efficiency, optimise processes, and raise city dwellers' standards of living.
- AI and IoT technology working together in harmony. AI can examine the massive volumes of data generated by IoT devices to obtain insightful knowledge and make defensible decisions.
- How crucial it is to develop AI with humans at its core. Human requirements, moral issues, and values should be the main priorities in the design and implementation of AI.
- The prospective use for artificial intelligence to solve urgent urban issues. AI can lessen the effects of climate change, ease traffic, and enhance public safety.

AI is going to be even more important in determining the future of cities as they develop and deal with more complexity. Cities can develop thriving, resilient, and egalitarian urban ecosystems that benefit all citizens by ethically and sustainably utilising AI.

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