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Artificial Intelligence in Smart City-Systematic Literature Review of Current Knowledge and Future Research Avenues

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Artificial Intelligence in Smart City- Systematic Literature review of Current Knowledge and Future Research Avenues

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Abstract: Artificial intelligence (AI) is fast gaining acceptance and applicability all over the world. AI has the ability to drastically alter our cities and society due to its advanced capabilities. Major technical, eco- nomic, and environmental developments have piqued mankind's interesting building a society that is technologically smarter and safer to live in. AI is involved in multiple domains of smart city such as infrastructure, transportation, environmental protection, power and energy, privacy and security, governance, Data Management, Healthcare etc. and the rising usage is anticipated to expand. In the present systematic literature review (SLR) on artificial intelligence in smart cities, an attempt is being made to examine and critically assess the earlier findings. It provides insights into developing urban artificial intelligence and the possibility for a smart city- AI symbiosis. In terms of approach, this viewpoint employs a detailed analysis of the current state of AI and smart city literature, research, advancements, patterns, and applications. As a result, it adds to ongoing scholarly discussions in the disciplines of smart cities and artificial intelligence. We performed thematic analysis over 100 papers and extracted domains and subdomains of smart city and AI to find out the research gaps. To conclude we present our recommendations as well as a future research avenue. As a result, it encourages further collaboration between AI and Smart Cities.
Keyword: Smart City, IOT, Artificial Intelligence, Applications, Sustainability

1. Introduction

Smart cities, which attempt to combine all aspects of urban life, have evolved in the last decade as a result of significant socioeconomic digitization. Cloud computing, IoT, and cyber-physical systems, which represent the latest chain in the industrial revolution, serve as the framework for integrating components of urban life in smart cities. [1]. Although smart city applications are expected to be a trillion-dollar marketplace in the next five years, the term "smart city" has yet to be defined. [2]. Several major components of smart cities, such as smart living, smart government, smart citizen (people), smart transportation, smart economics, and smart infrastructure, have already been built [3].

Smart cities have become an actual pick-up term for a variety of technologies, not only by introducing new applications but also by making existing services more accessible to citizens. In the light of urbanization, climate change, democratic flaws, and rising urban welfare expenditures, smart cities have emerged as an important approach for society's future development [4, 5]. "Smart cities" is a broad phenomenon that has been described variously by many experts. However, being a smart city necessitates accomplishing long-term social, environmental, and economic growth, as well as enhancing society living standards through the use of ICT and AI.[6].

Artificial Intelligence (AI) has the potential to be a revolutionary vehicle. AI is described as a system's ability to accurately read external input, learn from it, and apply that learning to accomplish specific goals and activities through balancing [7]. Artificial intelligence (AI) is rapidly gaining acceptance and usefulness worldwide. AI is predicated on the creation of autonomous agents that can explain and organize their way to their aim without relying on any pre- existing information of their surroundings [8]. By eliminating the need for human labor and greatly enhancing our scientific and technical advancement, AI has the promise of making us healthier, wealthier, and happier [9]. Because of its tremendous capabilities, AI has the potential to profoundly transform our cities and civilization. Major scientific, economic, and environmental advancements have sparked humanity's interest in creating a society that is more technologically advanced and safer to live in. Nowadays, AI has transformed our lives in many ways, from semi-autonomous cars on the roads to robotic systems in our homes, and it is likely to continue to do so for the coming years [10], trying to infiltrate every aspect of our lives, from health care to education, entertainment, and security. AI is used in a variety of smart city areas, including infrastructure, transportation, environmental protection, power and energy, privacy and security, governance, data management, healthcare, and so on, and its use is expected to grow [11].

Various studies on AI in smart cities have been conducted in recent years. The use of artificial intelligence in smart cities is an attempt to review and critically analyze previous discoveries. It offers insights on the

development of urban artificial intelligences as well as the possibilities of a smart city-AI symbiotic relationship. This viewpoint provides a thorough analysis of the state of the literature, research, advances, patterns, and applications related to AI and smart cities at the time. As a result, it contributes to ongoing scholarly debates in the fields of smart cities and artificial intelligence. An exhaustive literature evaluation is carried out between 2014 and 2021 to determine the depth of AI in smart cities. The following is a list of the paper's major contributions:

- Our main goal is to analyze the findings of previous research in identify the significant technologies and research gaps of AI in smart cities.
- This Paper will allow us to have a better understanding of the significance of technological use and its roles in the development of smart cities.
- This Paper will allow us to have a better understanding of the significance of technological use and its roles in the development of smart cities.

The structure of this paper is as follows. First, we'll go through the background of smart city (Section 2). Second, we will go through the research methodology (Section 3). Section 4 will next go through thematic analysis. Finally, we will review the important findings and set some future goals to ensure that AI produces the greatest results for smart cities.

2. Background

A smart city is one that has sophisticated modern technology, new applications, and creations that make life simpler, more efficient, and easier. City residents' lifestyles are becoming more suitable for quality living and efficiency as a result of smart cities. Sustainability, decentralization, information integration, and communication technology are all essential components of smart cities. Transparency, reliability, optimization, and monitoring are also necessary for successful deployment [12].

2.1 Smart City Infrastructure:

The establishment of the overall smart city framework and architecture begins with smart city infrastructure [13]. Some essential smart city infrastructures are:

2.1.1 Physical Infrastructure:

It is the application of information and communication technology (ICT) to integrate cost-effective and intelligent physical facilities such as solid waste management systems, electricity and water delivery networks, high-speed broadband services, housing stocks, and urban mobility. For example, (i) solid waste management refers to waste generation, prevention, characterization, monitoring, handling, reuse, and disposal; and (ii) urban mobility refers to the quality of urban walking, cycling, and smart transportation systems.

2.1.2 Institutional Infrastructure:

The basic functions of activity, such as management, governance and planning with the goal of including inhabitants in decision-making processes. The institutional infrastructure collaborates with both the central and regional administrations to get the most out of the smart city. It is critical to process information in real time under complete Service Level Agreements to ensure that such judgments are made without arbitrariness or discrimination (SLA). Furthermore, ICT aids in the creation of an effective, responsible and transparent citizen-centered system.

2.1.3 Social Infrastructure:

It includes a variety of frameworks for the development and progress of individual and societal resources, as well as intelligent and transparent, integrated infrastructure to meet people's diverse social needs and services, such as education, health, the environment and inclusive planning.

2.1.4 Economic infrastructure:

It refers to the basic facilities and amenities that help with the development and distribution of economic activity, as well as the construction of suitable infrastructure to create jobs and attract investment [14]. Although this type of activity does not directly produce products or services, it does have an impact on external economies by influencing agriculture, manufacturing and commerce to produce more. The concept of a smart city may undoubtedly affect any area of today's culture. As a result, establishing smart cities and raising the conditions for networking and communication is critical for capturing and translating vast amounts of data.

2.2 Smart City Layered Architecture

In order to accomplish comprehensive sensing and smart city management, the smart city manipulates data collected from the physical world, data transmitted in the communication world, and data processed in the information world. Sensing elements, heterogeneous network infrastructure, processing units, and control and operational elements are all incorporated, as indicated in fig. 3.1.

2.2.1 Sensing Components:

Sensing elements, to put it another way, serve as a bridge between the worlds of physics and knowledge [15]. The sensing devices are either deployed by the govt, organizations, and enterprises, or are carried by customers, as stated above. They also include wearable systems, industrial sensors, and mobile devices (e.g., smartphones, smart meters, and video monitoring cameras).

2.2.2 Heterogeneous Networks:

The sensing information is gathered in a variety of ways due to the cohabitation of big sensing instruments and numerous applications and the heterogeneous network design plays an important role in aiding the smart city. Heterogeneous networks include cellular networks, wireless local area networks (WLANs), large area networks (WANs), device-to-device (D2D) communications, millimeter-wave communications, sensor networks, and other forms of networks to allow smooth switching.

2.2.3 The processing unit:

It interprets and processes the collected sensory input from the real environment for decision-making using efficient cloud storage servers, abundant databases, and dedicated control systems. The processing unit in a smart city is in charge of the information world. Specific agencies, such as the government, hospitals, factories, and consumers, are given access to the information collected. They may also establish standards or policies for smart city decision-making and regulation.

2.2.4 Control and Operating Components:

A smart city feeds back through control and Operating components, such as servo actuators or smartphones to impact the real world, based on the processing unit's optimization and decisions. In order to give a fair quality of life in a smart city, this control and running aspects refine the real environment and make modifications. They also explain how smart cities work in both directions (i.e., sensing and control). It can track and operate any system or part of a smart city to make it perform properly and "smart" by learning knowledge about the physical environment from its two-way flow.

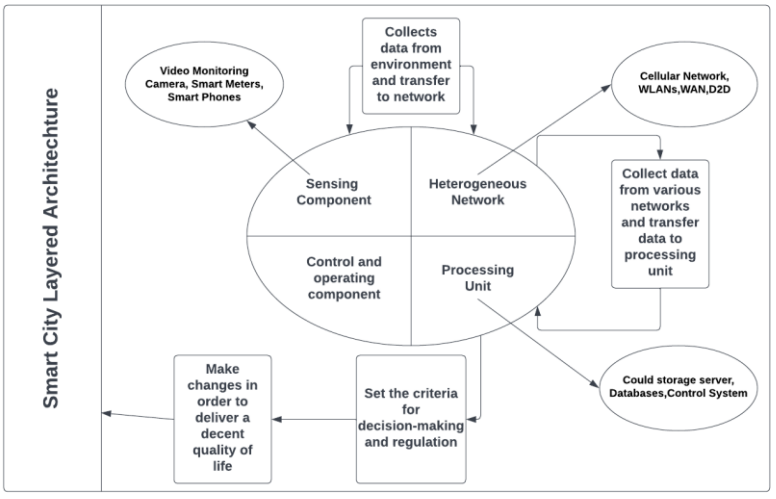

Fig 3.1. Smart City Layered Architecture

The demand for smart cities, or the effective implementation of smart cities, is enormous in today's world. In today's world, it is the next ground breaking technical development. The advantages or contributions that smart cities will bring are mentioned further down.

2.2.5 Sustainability:

One of the most crucial characteristics of a smart city is its ability to be sustainable. A smart city focuses on establishing smart and sustainable healthcare, a sustainable energy consumption framework, and assisting in the preservation of a more environmentally friendly lifestyle [16]. Another important component in the development of smart cities is the intelligent use of natural resources, waste and pollution management, climate change and social difficulties. Humans will be prioritized when technology is adapted to improve people's quality of life as a result of smart cities.

2.2.6 Security:

When it comes to smart cities, security is the most import factor. Each component to fa smart city is linked via the internet to the rest of the network. Thanks to blockchain technology, which serves as the smart city's security provider, smart city infrastructure, which is state-of-the-art technology, aids in strengthening physical architecture and cybersecurity [17]. Blockchain technology's pseudo-anonymity ensures the secure transmission of massive data in the smart city. Because blockchain prohibits the use of any third-party solution in any of its processes, it ensures that the entire operation is free of fraudulent activity. Cyber-attacks on numerous infrastructures are inescapable when technology, namely the internet, is involved. Smart cities typically use co variety of sensor networks and IoT devices to build context-aware apps and sensor networks are more vulnerable to cyber-attacks due to their infrastructure [18]. Devices may be out of reach as a result of infrastructure attacks, or data may be lost; as a result, smart city residents may experience a privacy breach or malicious codes may be injected to spread false information that has a catastrophic impact on the overall environment and living standard and thus infect smart city infrastructure. To avoid this smart city always use cutting-edge security attack counter measures whenever an attack occurs [19].

2.2.7 Connectivity:

It is such a vital aspect that a smart city would be impossible to imagine without it. Connectivity is essential in a smart city and it can be wired or wireless. The easier it is for data to flow in smart cities while offering real-time application and security services to residents, the smoother the connection is.

2.2.8 Decentralization:

When it comes to smart city development, decentralization is the primary goal. A smart city's major goal is to decentralize governance, healthcare, education, and other services. This is done so that consumers can receive whatever service they want at any time and from any location. Transparency and immutability will prohibit any type of fraud if individual records are saved using blockchain technology. On an individual and company level, we can always employ digital identification elements for authentication.

3. Research methodology

The SLR is an approach that allows for a thorough assessment of the state-of-the-art in any given research field while also identifying research gaps to encourage further exploration and knowledge expansion [20–22]. We use an inductive technique to develop concepts of influencing aspects of algorithm aversion in order to execute SLR. This SLR reviewed the prior research in the following order: identification, selection of those that were relevant, information retrieval, data summarization, and finally, delivery of the findings. To assure the consistency and accuracy of our findings, we used standard method sand followed the steps below:

- **Step I:** Design the assessment by defining the research criteria that will be used to find relevant papers.
- **Step II:** Characterizing study selection-inclusion and exclusion criteria
- **Step III:** Review past research and collect data while using several screening levels to analyze content and extract data.
- **Step IV:** Executing data by combining the results of the study. Synthesize from extracted data and analysis.

4. Review Designing/ Planning

The creation of a research protocol is the initial step in conducting an SLR. The creation of a research topic, which will direct the report's succeeding phases, is the first step in the search technique. Choosing a search strategy, locating relevant studies, creating inclusion and exclusion criteria, and selecting a synthesis approach are all parts of these processes. We started by getting the RQs ready for this SLR. We looked at a well-known database—Scopus—to address these RQs. In order to explore databases and further define and improve the comprehensive keywords that would be used as search strings, we first chose the main term "AI and smart city." Our search included all relevant studies and was not restricted to any one-time frame.

4.1 Characterizing study selection

The unit of analysis for our SLR was determined to be academic research papers. Then, in order to identify the particular study papers, we specified the inclusion and exclusion criteria. We identify inclusion, exclusion, and the area of the re-view in order to base our evaluation on high-quality evidence. Only those papers are chosen for evaluation that precisely satisfy all of the requirements.

4.1.1 Inclusion Criteria:

- The study must address artificial intelligence in smart cities. This criterion allows us to rule out research that focuses solely on artificial intelligence or smart cities.
- We take into account research that was published before November 2021.
- The research must be written in English and published in a peer-reviewed publication.
- The research must focus on how AI could be used in a smart city. As a result, we concentrated on those studies in which we discovered a relevant relationship between AI and smart cities.

4.1.2 Exclusion Criteria:

In addition to the inclusion criteria listed above, we use the exclusion criteria listed below to ensure a more representative library of research.

- Conference papers, book chapters, position papers, review papers, short papers (less than 6 pages [23]), seminar papers, term papers, panel discussions, posters, editorials, commentary, keynote addresses, tutorial summaries, and technical articles are all excluded.
- We eliminate any research that does not address the relationship between AI and smart cities.
- All research that does not meet the minimal threshold limit of standard evaluation criteria are eliminated.
- We do not accept studies that provide a review of the literature on the present issue.

Inclusion Criteria	Exclusion Criteria

Article focusing on AI in Smart City	Article that fails to address AI in smart cities.
English-language articles with peer review	Articles not written in English
Journal articles published before November,2021	Workpapers, conference papers, project reports, and white papers.
	Articles that covered the same subject twice.

Table 3.1 Characterizing Criteria**.**

5. Data Extraction and Analysis

Initially, we used Google Scholar to look for publications using the phrase 'Smart city and AI.' By analyzing the titles, abstracts, and keywords from the top 100 papers obtained in this initial search, we created a comprehensive list of terms and established the final search strings. The subsequent search was eventually generated using this method.: (AI and Smart City) OR ('Artificial Intelligence and Smart City'). Scopus yielded a total of 2042 studies. We did not limit our study's election to a certain time period. However, a main examination of earlier studies found that smart cities have sparked academic interest since 2014. However, we focused at the latest seven years of paper from 2014 to 2021. The filtering criteria were increased beyond the fundamental bibliographic details, such as journal title, author and year to include each article's abstract. The screening procedure was carried out in four steps. This procedure was carried out independently by the two authors, and at the end of each step, a conversation was held to establish a decision on moving on to the next level.

First, we evaluate the papers from 2014 to 2021, which totaled 1242. Second, after applying the previously outlined inclusion and exclusion criteria to these 1242 investigations, we were left with 500 studies. Third, we excluded papers that focused on either AI or Smart city but did not clearly cover AI deployment in Smart city. Following this phase, 150 studies remained. Finally, we reviewed the remaining 150 studies and selected those that covered AI applications in smart cities. This left us with 100 studies and we chose these 100 publications for our next research to fulfill our requirements. Fig 3.2 shows all the steps for data extraction.

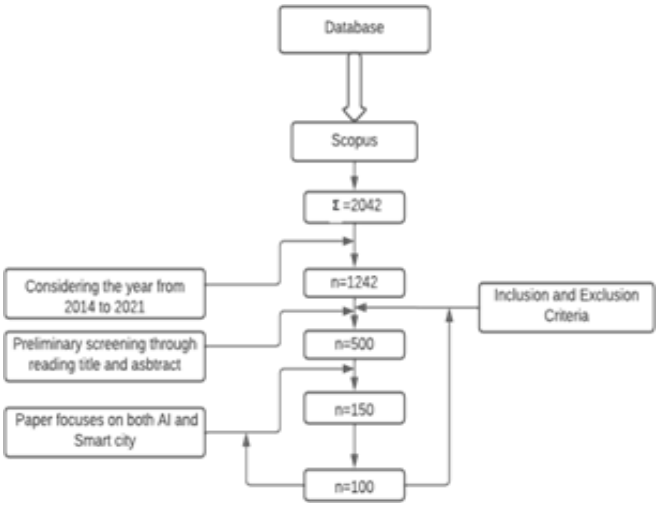

Fig 3.2 Data Extraction

6. Data Execution

Based on descriptive statistics, we created a research profile for the 100 selected studies, which included the publishing origin, publication year, geographic scope and methodology utilized, in accordance with previous studies. The small number of research published previous to 2016 is highlighted by categorizing them by year, with a rapid growth from 2019 to 2021. There are 52 publications linked to smart cities and AI among the 100 research, while the rest are conference papers. Springer Science and Business Media DeutschlandGmbH publishes the majority of articles and conference papers. A large number of studies were carried out in the India (15 articles), China (13 articles), Australia (7articles), United States (5articles), Italy (5articles) and United Kingdom (3articles). Based on descriptive statistics, we created a research profile for the 100 selected studies, which included the publishing origin, publication year, geographic scope and methodology utilized, in accordance with previous studies. The small number of research published previous to 2016 is highlighted by categorizing them by year, with a rapid growth from 2019 to 2021. There are 52 publications linked to smart cities and AI among the 100 research, while the rest are conference papers. Springer Science and Business Media DeutschlandGmbH publishes the majority of articles and conference papers. A large number of studies were carried out in the India (15 articles), China (13 articles), Australia (7 articles), United States (5 articles), Italy (5 articles) and United Kingdom (3 articles). Fig 3.3 represents number of selected publications from each year.

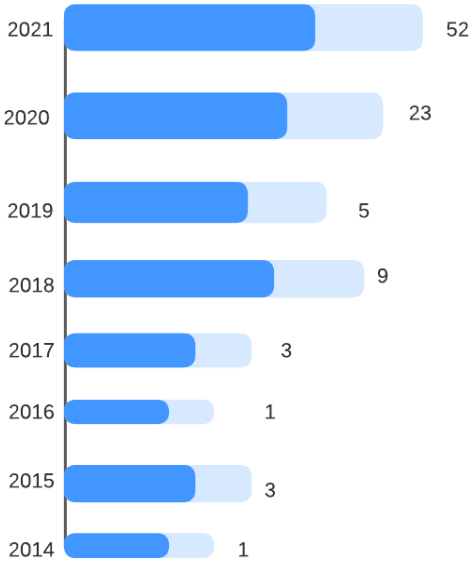

Fig.3.3 Data Execution

7. Thematic Analysis

We started by reading the Excel data file containing major findings from primary research, and then we gave each study a descriptive description based on what we had read and our overall experiences. This stage allowed us to have a better understanding of the research. Second, because we were interested in investigating themes Smart city and AI, we worked on the Excel data file associated with this. We analyzed all data and assigned one or more conceptual labels to produce a first-order theme (T1). Third, using an onto logical approach [24], first-order the matric labels were linked together based on similarity and connection to produce second and subsequent orders of themes (T2, T3) as needed. Fourth, fundamental thematic topics (Themes) related to the current study's issue were discovered. Fifth, derived themes were summarized in Tables and organized by the matric region (super theme), resulting in a subtheme structure. A description of each theme was also presented [25].

7.1 Environmental Protection:

7.1.1 Air Quality:

It has significance in the field of AQ prediction, as it investigates the idea of directly including pollution sources into the prediction model. Previous study has used just context information for the prediction process [26], Others, however, have just improved the current prediction algorithms by taking into account feature extraction from time series with fair pollutant concentrations and weather factors. Long-term series and short-term pollution sources generate low frequency high peak pollution, which is exceedingly difficult to anticipate, while also understanding the significance of a robust machine learning prediction method. More study is needed to incorporate these strategies [27].

7.1.2 Water leakage:

The problem of water leakage has spawned a slew of innovative solutions. However, a step toward smart cities may be seen in the detection and localization of water Leaks in water Nets with the use of an ICT system using artificial intelligence techniques. As a result, many precautions are taken to assure this. These include developing a hydraulic model for the water supply network, calibrating the model, running

the hydraulic model through several computations for simulated leaks, choosing a neural classifier for leak location, and identifying water leaks. The problem of water leakage has spawned as Lew of innovative solutions. However, Finding and Locating Water Leaks in Water Nets with the Help of an ICT System and Artificial Intelligence Techniques: A Step Toward Smart Cities. As a result, several safe guard shaves been implemented to ensure this. Planning a SCADA monitoring system for the water supply network, trying to formulate a hydraulic model for the water supply network adjusting the hydraulic model, execute multiple calculations of the hydraulic model for simulated leaks, determining a neural classifier for leak location, and detecting water leaks are some of the setbacks [28]. The analysis revealed that the MLP network is better suited for handling this kind of issue. Additionally, the calculation of neural networks model shows that it may be a valuable and practical tool for finding and discovering concealed leaks in the water supply network. This indicates that when it comes to finding leaks, a simpler network performs better than a more complicated network. Three components of an IT system must be disposable to handle the challenge of detecting and localizing water leaks in Water Nets: an appropriately built monitoring system, a precisely calibrated water net model, and a neural failures classifier. The hydraulic model of the network may be calibrated using data from the monitoring system, and the failures classifier can be built using this model. The identification of suspected water leaks may then be documented using the monitoring system, and the subsequent usage of the neural classifier will result in the leaks localization be unrecognized.

7.1.3 Environmental Intelligence:

Smart cities use cutting-edge technologies like 5G and beyond wireless connectivity to improve the quality of life of their people. Because of the explosive rise in the use of IoE technology and the resulting volume of data, a cutting-edge architecture is required to accommodate a wide range of applications in order to manage smart city resources efficiently and intelligently. As a consequence, a novel suggestion for developing a traditional resource allocation and task off-loading architecture for IoE devices in a smart city frame work was made (6G) [29]. A multi-layer intelligence enhanced 6G architecture for IoE devices in a smart city setting is offered based on the proposed intelligent model. As well as specific research topics for developing and evaluating the performance of each component in the proposed conventional and intelligent architecture.

7.2 Healthcare

7.2.1 IoT healthcare system:

In health care, smart solutions based on AI and the Internet of Things have shown to be quite beneficial. Edge-enabled IoT, in which a large number of embedded sensors and IoT devices link to deliver diverse services to the community for the well-being of their residents, might transform the healthcare industry. Interconnected IoT devices create a massive volume of IoT data in the present COVID-19 environment, which is increased by the existence of chronic illnesses and an aging population [30–32]. The environment is evolving at such a rapid pace that health care systems are struggling to keep up. To promote prompt treatment, it is critical to diagnose and detect ill- nesses at an early stage [33]. The expense of healthcare is also reduced as a result of this.

To that aim, the combination of edge AI with IoT has the ability to categorize and cluster this huge volume of IoT data, as well as generate predictions and provide early insights. This might help to solve the pandemic's worldwide challenge as well as other associated issues. The current study offers an edge AI- enabled IoT healthcare monitoring system for a smart city that may significantly enhance healthcare facilities and infrastructure while also ensuring that patients are treated promptly. This might be extremely beneficial in terms of bolstering the health system, especially in the event of a pandemic. For health care services, the notion of an end-to-end network slice is also offered, which provides lower latency and scalability.

7.2.2 Corona Virus outbreak and smart city:

This paper explores how data sourced from an urban perspective can contribute to the medical narrative. The decision to concentrate on the urban realm in this manuscript stems from the fact that the current epidemic (COVID-19) is primarily transmitted through human-to-human contact, and in most cases, particularly when the spread is reported in another country, the first point of contact in an urban area, such as airports or subway stations, where large groups of people congregate [33]. Surveillance systems have been placed in most of these institutions, which are largely located in metropolitan areas, to guarantee that anyone displaying any symptoms of the disease is recognized and quarantined [34]. Even in these situations, anonymizing medical data is essential, as it appears to be in the current publication, to ensure that utilization of the technology in question does not run afoul of data privacy and security laws in various countries. New technologies, such quantum cryptography and blockchain, can be made to operate with data collection techniques in this situation and can aid in the conversation. Despite the undeniable functions that implanted devices play in giving valuable health information, the data transmission component of their operation has to be examined. First, communications are seen to be

geography-bound (limited to a certain spot), with the result that they seldom extend or communicate with their counter parts installed outside of their restricted locations. Second, these devices are frequently obtained and installed by independent companies who have their own set of rules for data processing and exchange, thereby linking cities to their product [35]. Furthermore, in the event of an emergency, such as the present COVID-19 epidemic or any other adherence to regulatory norms and international healthcare recommendations is critical. This would guarantee that both healthcare providers and the general public are kept informed, safe and within the law.

7.2.3 AI-based online triage model for hospitals in sustainable smart city:

Modern information technology is fully incorporated into the city's government system, traffic and transportation, medical resources, educational information, tourism conditions, and soon. It could be said that information technology has compromised every aspect of life; every movement in the city, every building, and every detail is under data monitoring and surveillance; and big data accumulates all of the city's information. The city becomes observable, real, visible, measurable, and quantifiable when the Internet serves as the carrier because seemingly insignificant data has tremendous meaning. The arrangement under consideration here performs admirably and fulfills the performance test requirements. It can assist patients identify medical institutions based on scientific evidence, guide people to seek acceptable medical treatment, and use less resources [36]. Patients who have long-term free medical services and a preference for major hospitals may enter them immediately. Preference is the primary cause of disordered access to medical services, as well as the general inefficiency of the medical service system and implementation in efficiency. Policies for diagnosis and treatment are organized in a hierarchical manner. This article [37] examines at how patients choose medical facilities, how they choose facilities individually, how group patients choose facilities over time, as well as how to support patient decision-making when they decide to seek treatment.

7.3 Transportation

7.3.1 Smart Mobility:

As the researchers have shown, KB included information on the environment, transportation, buildings, cars and town planning. These topics are also proven to be significant in the context of self-driving automobiles. Experimentation with a Scribbler robot was done to perform a prototype system that creates a transportation knowledge base that may be used for a variety of applications, including autonomous cars in a smart city setting. The experiment's first phase consists primarily of image gathering. This portion was [38] a success since they were able to create a program that could perform image analysis using Common Sense Knowledge. On a local scale, the prototype for automatic driving works well, but on a larger scale, it shows computing issues in gathering and processing photos while reasoning using the knowledge base. Even though energy and mobility are not correlated but as electric vehicles are reawakened, we need to think about the balance in both. So far, we have found a charging optimization component [39] that contributes to local grid load stabilization by making the best use of available renewable energy sources while maintaining the mobility of the involved users, an inter modal trip planning component (which considers user requirements as well as various mobility and information services to propose a solution tailored to the specific user), and a practical attempt to merge the two model which is Energy domain model, mobility domain model to increase the performance of the electric vehicle. Recent studies have shown the application of artificial intelligence for Smarter mobility. For example, collecting weather sensor data to detect the useful data of the environment, transportation networks, etc. while making a journey plan [40]. We see the usage of NLP to interpret the raw data, Data normalization, discarding the unreliable data are also done to get high-level concepts. Other data sources are also cross-referenced with social network data in order to filter noisy in- formation, provide reliability, provide event explanations, validate the detection system's conclusions as well as to detect disruptive events.

7.3.2 Smart Parking:

Sensors, real-time data collection and analytics, and automatic payment systems combine to form a smart parking system that allows individuals to find parking in their desired location and pay the amount due in advance. In the communities where people work and reside, traffic contributes to pollution and noise. Intelligent parking provides a solution to the problem [41]. By focusing on street parking occupancy, a predictive forecasting framework within the Smart Mobility sector has been developed. To solve the cities' parking problem, researchers have provided are liable short-term estimation of parking space occupancy (for the next few hours). To improve forecast performance, a variety of machine learning approaches including Kalman filter, MSTARMA, LASSO, multi-layer Long Short-Term Memory (LSTM) and integrated numerous information sources were exposed, taking into account traffic scenarios, meteorological data and customer transactions. Another system is an edge computing surveillance system, which uses smarts, efficiency, and reliability to identify parking space occupancy. This system dealt with finite network bandwidth challenge in real-time video analytics by keeping the data transfer volume small, to identify in harsh illumination and occlusion circumstances used a combination of background subtraction and SSD detection. The entire design [42] took into account the

system's stability and scalability, as well as the balance between computational load and data transfer volume.

7.3.3 Autonomous/Electric Vehicle:

Focusing on autonomous cars, or those that conduct automated driving and must make autonomous or independent, judgments, a method based on commonsense knowledge (CSK)from global repositories has been proposed to imitate intuitive human like decision-making in autonomous vehicles. The repository under consideration is Web-Child, which has a large number of CSK ideas, attributes, and relationships and researchers looked into it as well as related domain-specific knowledgebases [43] (domain KBs) to see if they could use them in their suggested strategy. As a result, a transportation domain KB is created, which incorporates CSK as well as the requirements of autonomous cars. This would be important in directing automated driving and bringing systems closer to human cognition's limits.

7.3.4 License Plate Recognition:

The algorithm used in the system is more robust to many challenging circumstances such as images captured in adverse weather, skewed plates, more information added to the plate, and plate alignment about the brightness because it not only extracts character/number features but also determines cluttered background features. As an input, the vehicle image is converted to gray scale and then canny edge detection is used to improve the image's required sharpness, resulting in a feed for the first planned CNN's detection phase. The architecture of a CNN model is designed to categorize the region of interest in license-plate/non-license plate images produced by feature filtering, feature localization and feature selection. The feature detection procedure is used to create this Visual Saliency map. The license plate is extracted using the feature detection procedure in this Visual Saliency map. During the detecting process of license plate variants that include the surroundings, a series of obstacles may arise. They include (a) plate location in the image, (b) multiple number of plates in the image, (c) plate orientation towards brightness, (d) wear and tear distortion, cleanliness, and (e) additional information (stickers) on the plate [44]. A new data set containing several of the aforementioned hard concerns is provided to test the algorithm's robustness. In comparison to the other traditional and CNN-based methods, the performance and accuracy of the LPDS system demonstrate the usefulness of the proposed schemes.

7.3.5 Traffic Management:

A generic neuro-inspired framework for the control of complex systems applied to smart city challenges, with a proof of concept focusing on urban transportation as one of the city's primary integrative subsystems. The perception function of the framework helped it to function better. More specifically, it is addressed how traffic data can be used and analyzed so that the system can be reconfigured in proportion to the number of vehicles. The framework also dealt with forecasting short and long-term changes in car flow. The decisional basis for reconfiguring the traffic management architecture is based on predicted traffic values [45]. In order to avoid junction congestion, local junction controllers set the traffic light length of the associated traffic signal based on the projected car flow. Validity was determined by selecting an approach to urban traffic control architecture that had previously been established and largely implemented had been tested on real data and had been upgraded specifically for this purpose. Adaptation to the traffic context was accomplished by varying the duration of each light while maintaining the cycle's sequence and duration, which was referred to as a light scenario. The major part [46] of the problem was solved at the supervisory level by correctly identifying the traffic structure that necessitates a change of light scenario, as the functional requirement for the control architecture appropriately apply learned behavior which necessitates continuous monitoring. Different traffic scenarios might be imagined based on the expected traffic information. The use of computer vision technology to categorize pedestrian traffic signals efficiently solves the problem of traffic monitoring and surveillance. Data augmentation, as well as photo classification utilizing transfer learning, were employed to address the issue of limited data (DNN). In this context [47], the employment of the pretrained model MobileNetV2 has also been seen. As a classifier for picture detection an artificial neural network and arrange of other machine learning approaches are used to evaluate the implementation of a 3Dcolortexturefeature for traffic sign detection.

7.4 Safety

7.4.1 Privacy:

Data protection and privacy are currently a source of concern for society, as there are an increasing number of networked systems sharing information without a robust mechanism for auditing before deploying them into live mode and ensuring that everything is correctly controlled [50]. A methodology [51] has been suggested that assures that any system or device used in day-to-day operations in a smart city is changed to ensure that all minimal rules and standards are followed, reducing the chance of information being handled in correctly. Furthermore, this model advances the state of the art by incorporating an Audit Process Framework that incorporates Artificial Intelligence and Cognitive Services. This study examined the security of several IoT application technologies based on IoT security requirements. The use of LoRa, a new wireless communication technology, to assure IoT signal security is highlighted. LoRa signal sources [52] grow in tandem with network growth, ensuring that LoRa conflict signals can correctly track and identify information and preventing hostile signal source attacks

from jeopardizing network security. The fairness of REBEB, a new back-off algorithm, is much superior than that of BEB in networks with varied numbers of nodes when the time slot interval is selected depending on LoRa. Furthermore, its security is increased to some level, and the REBEB algorithm essentially meets the communication requirements of the throughput protocol. To summarize, an IoT system based on LoRa communication technology effectively improved the system's security performance in the building of smart cities, as well as avoid security issues in IoT signal transmission.

7.4.2 Security:

From an AI standpoint, I-VEmoSYS, an integrated virtual emotion system, has been introduced. It was divided into two subsystems. On one hand, as the first subsystem, a promising AI-enabled AI-VEmoBAR, AI-VEmoFLOW and AI-VEmoMAP, respectively has been introduced and how they are run in the system [53] and deal with their essential security difficulties and issues has been explained. The establishment of VEmoPROPERTY and the design of an AI-VEmoBLOCK as the second subsystem, on the other hand, was presented, with security challenges and possible solutions for secure CPS-enabled advanced smart cities discussed.

7.5 Power and Energy

7.5.1 Intelligent energy optimization:

EDA-EM is used to improve the energy distribution by predicting seamlessness data. The device information, which varies every time, is deployed using big data analytics [54]. Big data, artificial intelligence, and energy management are used to evaluate bigdata processing in this study [55]. The proposed strategy improves energy allocation, conservation and data processing rate, according to the performance evaluation [56]. On the contrary, it cuts down on data loss and processing time. The EDA-EM achieves a distribution rate of up to 95.13 percent, which is unattainable by any other method. Examining smart metering and non-intrusive load monitoring (NILM) in the context of profiling electric appliance electricity has been used to establish a case for the optimization of energy consumption. For NILM, a hybrid genetic algorithm, support vector machine multiple kernel learning approach (GA-SVM-MKL) was presented, with 20 different types of appliances taken into account. The genetic algorithm aids in the solution of multi-objective optimization problems and the development of the best kernel function based on multiple kernel features [57]. The classifier's sensitivity (Se), specificity (Sp) and overall accuracy (OA) are the performance indicators. It combines artificial intelligence, IoT and big data analytics insights and questions them in the context of energy sustainability.

7.5.2 Smart Monitoring:

A real-time IoT-enabled persons detection system is introduced for person monitoring and detection. The created system uses an internet connection to execute image processing tasks in the cloud, lowering computational costs by processing high-resolution photos in the cloud [58]. A real-time IoT-enabled persons detection system is introduced for person monitoring and detection. The created system uses an internet connection to execute image processing tasks in the cloud, lowering computational costs by processing high-resolution photos in the cloud. For person detection, a pre-trained Cascade RCNN, a deep learning approach, is used. It is an object detection architecture designed to increase performance by increasing intersection over union (IoU) thresholds. Because the architecture has been pre-trained using the COCO data set and the person's anatomy appears differently from an above perspective, more training is required to improve the detection results. The architecture was trained for overhead person photos using transfer learning, and the newly taught feature layer was applied to the current architecture. The results of the experiments show that further training improves the detection architecture's performance by 0.96percent. Face photos were captured from security cameras in a smart city's face database, which was then processed using various image processing and intelligent algorithms to overcome the aforementioned traditional limitations in face identification. The techniques were successful in examining each pixel in a face image and determining the exact location of the face as well as the geometric aspects. Finally, adaboost large memory storage and retrieval neural network was used to do face recognition (LAMSTAR). The newly established LAMSTAR face recognition process successfully utilized memory, which registers face-related information that is used to forecast the face if an unauthorized user enters smart cities [59]. The face identification process was made easier because to a thorough evaluation of the facial features, face shape model, and relationship between the face pixels. The efficiency of the LAMSTAR system is analyzed using MAT-LAB tool findings and discussion of several performance indicators such as loss rate and efficiency metrics. The efficiency of the system was built using the MATLAB tool, and the system obtained 99.63 percent accuracy while recognizing the image.

7.6 Data Management

7.6.1 Big Data Analytics:

The DBN-R-LSTM-NN algorithm is used to classify and predict fire outbreaks based on data obtained from IoT sensor devices. The Arduino MCU was used to process a vast amount of data collected from IoT devices, in which the system worked as a brain for acquiring data and the data preprocessor assessed the features for classification. Temperature, Flame, Smoke, FFMC, RH, and DMC were the most important features, which were used to detect fire outbreaks based on the class labels '0' and '1 [60]. The

model detected the fire outbreak with 98.4 percent accuracy and a minimal rate of 0.14 percent. The training and validation data are examined using 70 percent and 30 percent of the data, respectively. This model assisted in detecting a fire outbreak and allowing fast action to be taken. In the framework of Smart Cities, a methodology based on visualization approaches for Bigdata has been presented, with the goal of improving the evidence-gathering process by supporting users in decision-making [61]. A case study [62] based on the call service of a fire department, in which data from IoT devices and incoming calls were examined. In this situation, the results were applied to data received through citizen calls [63]. As a result, the outcomes of this study aided resource optimization by providing decision-making evidence. When a call is received, firefighting battalions, for example, will be better positioned to respond.

The below table.3.2 shows comprehensive analysis of different methods based on themes and sub-themes:

Themes	Subthemes	Research Gaps	Future Research Avenue
Environmental Protection	Air Quality	1. The utilization of real-world data sources raises uncertainty due to probable disturbances or malfunctioning measuring stations. 2.How can air pollution devices be explored for more accurate data?	Context aware AQ models can be used to measure the Air Quality.
	Environmental Intelligence	Is the proposed architecture and model sufficient to assure the performance of each individual component of a smart city's 6G wireless network?	How can we build artificial general intelligence or artificial super intelligence (friendly AI).
	Water Leakage	1. Why does the network provide such complicated results in the problem of location of leaks? 2. Is it possible for real data about the water net to be more effective if it is tested?	1. Implementation of improved algorithms to locate water supply network leaks where measurement points are few in monitoring systems. 2. How do you design a research topic for optimal resource allocation using economic theory and how do you define a cost function with restrictions for the conventional and intelligent model? 3.What AI and ML approaches may be used to create an intelligent model?
Heath care	IoT health care monitoring	1. Is an IoT health care monitoring system capable of ensuring the immediate treatment of patients in a pandemic situation?	1.What percentage of the time can health monitoring technologies, such as temperature sensors, discover irregularities in the early stages of disease detection?
	Corona Virus outbreak and smart city.	How to manage data access that may be sensitive to national security considerations.?	1. The standardization of protocols for improved communication in smart cities. 2.To assure the livability dimensions, smart city technology tools must be established.
	AI-based online triage model for hospitals in sustainable smart city.	1. How can the current automobile city of high-quality medical resources be adjusted for, the traditional medical service model enhanced, and the initial unfeasible medical resource supply structure modified to increase the	1. How to manage big data of smart cities for future business mode? 2. How can the original unsustainable medical resource supply structure be altered, the conventional medical service model improved, and the existing automobile city of high-quality medical resources taken into account to raise the overall efficacy of the medical service

		overall effectiveness of the medical service system?	system?
Transportation	Smart Mobility	How do we solve the high computational issues and improve accuracy and decision making of autonomous cars?	To evaluate the CSK-enabled technique, deploy strong robots and better object detectors, with the assumption that CSK will improve object detection accuracy, decision-making in simulated automated driving and therefore improve autonomous cars. Solutions for difficulties relating to energy and mobility.
	Smart Parking	1. Using forecasting algorithms and time series data to create meaningful predictive analytics framework is a difficult task. 2. One of the most exciting issues in smart city research is delivering novel services and obtaining new knowledge from data generated by IoT devices.	Obtaining experimental data and conclusions from a wide range of real-world circumstances might be a useful resource for future research.
	License Plate Recognition	1. Combining diverse feature maps might be problematic. 2.The rare specific patterns that can use the majority of license plate detection systems to fail. These difficult patterns are seen on a sign or object that resembles a license plate. Correctly recognizing these patterns is a major challenge.	Reducing noise in feature maps to get better results and upgrading algorithm to detect misdetection or unidentified patterns more accurately can be future research avenue.
	Traffic Management	1. Limited Data is a major issue. 2. No research has been done in the context of monitoring drivers' behavior.	1. Improving the data set and improving the presented strategy by merging Neuro-Fuzzy methodologies. Further research into combining traffic sign systems with other aspects of driver behavior that can be combine utilizing AI technology could be seen as a future development opportunity.
			2. Designing a solution that not only employs vehicle-to-vehicle(V2V) communication, but also vehicle-to-infrastructure (V2I) communication, so that vehicles have worldwide knowledge of the traffic situation on the map. Furthermore, examine the usage of the MicroFogparadigm to carry out the decision-making process in route recommendation could be seen as a future development opportunity.

			3. Incorporate vehicle-to-vehicle communication and the influence of speed breakers on traffic flow and congestion could also be a future avenue.
Safety	Privacy		Identify and test on real-world situations where data protection and privacy are needed and confirm the efficiency of disruptive implementations.
	Security	How to detect malicious attackers and penetrators to ensure the integrity of the virtual emotion information transmitted from a source user?	Issuing provider identity with anonymity should be prioritized. To support the system's reliability and confidence among users, an AI-based identification scheme and safe access control should be established.
Power and Energy	Smart Monitoring		Improve Face shape generating model and facial point detection procedure with the use of optimized strategies.
Data Management	Big Data Analytics		1. Focusing on conducting specialized local and global analytics over time to ascertain the value of the framework with its ability to continuously update based on new data can be future research avenue. 2. Implement framework on a cloud environment to simulate the complete local and global functionality with the interlayer communications.

Table3.2 Comparative studies of different Models.

8. Conclusion

Cities are being confronted with a variety of concerns, including privacy and security, healthcare, environmental issues, and many more. To address these issues, cities are beginning to integrate new technology into their basic tasks. Through a literature study, this research demonstrated that Artificial Intelligence is one of the important technologies of smart cities. This technology is used to enhance infrastructure, maximize resources and ensure public safety, among other things. However, there are always certain gaps in the deployment of AI in smart cities. And we attempted to bridge such gaps by proposing some future initiatives to enhance the AI implementation in smart cities, which would result in improvement in people's quality of life.

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