THE ASIAN BULLETIN OF BIG DATA MANAGMENT
Vol. 4. Issue 1 (2024)
https://doi.org/ 10.62019/abbdm.v4i1.115.

ASIAN BULLETIN OF BIG DATA MANAGEMENT
ISSN (Print): 2959-0795
http://abbdm.com/
ISSN (online): 2959-0809

# Smart Healthcare Management Model for Proactive Patient Monitoring

Ammad Hussain*, Muhammad Azam, Shehr Bano, Ahmad Nasir, Aimen Zara, Saba Parveen

**Chronicle**

**Article history**
**Received**: February 14, 2024
**Received in the revised format:** Feb 21, 2024
**Accepted:** Feb 21, 2024
**Available online:** Feb 22, 2024

**Ammad Hussain, Muhammad Azam, Shehr Bano, Ahmad Nasir, Aimen Zara, and Saba Parveen** are currently affiliated with the Department of Computer Science Institute of Southern Punjab Multan, Pakistan.

**Email:**ammadhussain709@gmail.com
**Email:**drmuhammadazam01@gmail.com
**Email:** shehrbano1050@gmail.com
**Email:** rao.hot11@gmail.com
**Email:** aimen.zara2014@gmail.com
**Email:** sabaperveen724@gmail.com

**Corresponding Author***

**Abstract**

The rapid development of Artificial Intelligence (AI) is leading urban centers to employ AI technologies to improve efficiency and solve urban problems. This research proposes a Centralized System Model for Smart Cities (CSMSC) that centralizes AI-oriented data acquisition, processing, and decision-making. CSMSC uses real-time sensor networks for data collection, sophisticated AI algorithms for nuanced data interpretation, and unified storage for streamlined information management. Additionally, CSMSC integrates AI-based analyzers to autonomously produce alerts, evaluate their urgency, and decide upon suitable responses, enabling quick and targeted city interventions. The paper combines field evidence with theoretical frameworks to highlight the transformative potential of cognitive sensing and machine learning in smart city development. Recent studies have shown that AI on edge is revolutionizing the infrastructure of smart cities by bringing advanced intelligence and real-time analytics closer to the data source. AI on edge enables real-time decision-making, reduces latency, optimizes bandwidth usage, and enhances privacy and security. The potential benefits of using data analytics in smart cities are significant, and future research should focus on developing new algorithms and tools to analyze data and explore new IoT and machine-learning applications.

**Keywords:** Centralized System Model, Smart Cities, Artificial Intelligence, Urban Management and Governance,


## INTRODUCTION

Smart cities have been gaining momentum in the last several years. To overcome these obstacles, increase productivity, and better the urban experience, smart city efforts are utilizing data-driven solutions and technology. Centralized System Model for Smart Cities (CSMSC) is a new solution that addresses the shortcomings of traditional smart city development methodologies, such as a lack of integration, scalability, and real-time response. Smart cities result from the interplay of urbanization and the quick progress of technology, which is a pretext for the use of cutting-edge solutions to contemporary urban issues. This paper puts forward a new Centralized System Model for Smart Cities (CSMSC) to facilitate the application of AI at the city level and further urban governance. Historically, intelligent city undertakings have dealt with siloed data collection, storage, and analysis approaches, which have resulted in ineffectiveness and unintegrated responses to urban issues. The proposed CSMSC responds to these problems by providing a unified AI-driven urban management solution. Supported by the synthesis of evidence from empirical studies and theoretical bases, such as works by Allam (Dhunny,2019), (Singh,2020), and (Tan,2020), CSMSC sets CSMSC as the basis for responsive and cohesive urban infrastructure. At the core, CSMSC emphasizes integrating advanced sensor networks to perform real-time data acquisition as defined in the articles from 2021 (Yigitcanlar,2023) by Khan and Nazir. Through data collection on several urban parameters, including environmental indices and mobility systems, CSMSC provides a holistic view of the urban landscape.

Through AI-powered algorithms, CSMSC is a leader in data processing and analysis, using findings observed in studies as documented in (Ashwini,2022) and (Sleem & Elhenawy,2023). Through advanced AI approaches, CSMSC translates raw data into meaningful insights, obviating a need for manual work and ensuring timely and effective policy formulation and focused urban interventions. Notably, CSMSC adopts AI-driven analyzers that automatically generate alerts and estimate their relevance as a helpful starting point, taking inspiration from the studies (Ricardo,2020) and (Aritro,2023). This new approach simplifies the decision-making procedure, allowing the authorities to reactively deal with evolving problems related to cutting back on resource consumption and saving on relevant costs.

A centralized system model for smart cities (CSMSC) that integrates sensors, data processing, alarm generating, and decision support mechanisms is designed and implemented in this work to address urban issues. This study combines empirical and theoretical studies to expose the contributors of the CSMSC to the intelligent city literature. CSMSC proposes a shift in urban governance that may be achieved by applying AI technologies that transform data into usable wisdom, promote data-driven management decisions and produce outstanding citizen service. This will enable the creation of urban resilience, sustainability and livability. CSMSC suffers from the consequences of the current smart city management systems, which are integrated data systems, weak responsiveness and lack of real-time insights to complete urban governance and resilience solutions.

## LITERATURE REVIEW

The literature on smart cities and artificial intelligence (AI) encompasses a range of research on interdisciplinary relationships and applications of technology to urban development. There are many beneficial areas of AI in urban life, such as transportation, healthcare, governance, and sustainability. For example, the work of Allam and Dhunny (2019) highlights how big data and AI are related to the shaping of the smart city in the future, concentrating on their capacity to change things. Similarly, Singh et al. (2020) point to an intersection between blockchain, AI, and IoT for a sustainable smart city, highlighting technological integration towards smart city development. Yigitcanlar *et al.* (2020) lay down a detailed review of AI benefits and hazards when creating smarter cities, urging for discretionary approaches that take advantage of AI upsides but efficiently solve problems of AI downsides. The issue and possibility of general AI for a smart city intersection of change are pulled out by Al Ridhawi *et al.* (2021), highlighting the importance of scale and interoperability. Yiğitcanlar *et al.* (2021) stress the green AI agenda as the design of smart and sustainable intelligent cities in which the environmental effects of AI adoption are essential.

Literature also looks into artificial intelligence (AI) use in particular parts of intelligent cities. The authors show AI's position in the smart renewable energy market, for instance, Serban & Lytras (2020) and AI-based methods in smart city applications, such as those proposed by Peng *et al.* (2019). Nikitas et al. (2020) look at AI's impacts on transport and mobility, particularly how AI improves urban mobility systems. The study by Ullah *et al.* (2020) examines how AI and machine learning can contribute to smart city practices in improving city performance and quality of life.

On top of that, the research by (Badidi,2022) and Kuberkar *et al.* (2022) investigate AI's future in delivering smart city services. They focus on the Indian context, highlighting the advantages and drawbacks of adopting AI in varying urban environments. (Dash & Sharma,2022) give an overview of the role of AI in information management for Smart Cities, mentioning, among other benefits, that this technology can improve data-driven decision-making and governance processes. Smart city development is, however, equally addressed on social, economic and environmental fronts by the literature on technology. Gupta *et al.* (2022) did a bibliometric analysis of AI and smart cities literature, which outlines the research trends and knowledge gaps in the field. (Teredesai,2023) investigates social public health infrastructure for smart city citizens, emphasizing the need for inclusive and equitable urban development.

Various research has shown the incorporation of IoT and Artificial Intelligence (AI) in smart health systems Sowmitha *et al.,* (2022) Taher *et al.,* (2021). Internet-of-Things (IoT) devices like wearable sensors and medical devices permit continuous health monitoring, during which produced data gets analyzed by AI algorithms and leads to personalized suggestions and diagnostics. The role of machine learning and data analytics in healthcare data cannot be overemphasized (Dash & Sharma, 2022). AI algorithms can help clinicians take into account vast quantities of patient data to make correct decisions about diagnosis, treatment, and care management. Telemedicine platforms, empowered by the IoT and AI technologies, have emerged, particularly for the smart cities Sowmitha et al. (2022) Taher et al. (2021).

Such platforms enable patients to seek remote consultations with healthcare providers, thereby improving access to healthcare services and reducing the strain on traditional healthcare infrastructure. The main goal of modern health initiatives is to give patients control over their health data and integrate them into the care process. (Alshamrani,2021) Moreover, Sowmitha *et al.* (2022) IOT-enabled devices and mobile health apps promote patient participation in managing their health and well-being. Sowmitha *et al.* (2022) discuss AI integration in healthcare and smart cities. Authors consider using machine learning, IoT, and smart sensors to improve healthcare services in metropolitan areas. These technologies provide the foundation for home monitoring of patients and increasing healthcare delivery.

Ghazal et al. (2021) concentrate on IoT for smart healthcare by analyzing different machine-learning methods employed in the field. The authors review the role of IoT devices in remote health monitoring and present the advantages of employing machine learning algorithms for health data analyses. The systematic review points to the possibilities of IoT-based solutions in improving patient care. De *et al.* (2023) concentrate on smart city initiatives in India, emphasizing environmental sustainability and health care. Authors evaluate smart cities' associated promises and accomplishments in improving healthcare delivery and city life. They talk about the ability of AI-based technologies to deal with healthcare issues confronting urban settings. Rai & Vijayalakshmi (2023) analyze the role of information and communication technology (ICT) systems in Smart City healthcare, looking into ICT infrastructure as a supportive element of healthcare provision. The authors discuss the consequences of ICT in urban settings related to health care. They stress the role of technology exploitation in dealing with health disparities in smart cities. Despite the possible advantages, smart healthcare systems are confronted with interoperability, scalability, and regulatory compliance issues Taher *et al.* (2021). Future research directions are tackling these challenges, novel healthcare models using AI, and assessing the long-term effect of smart health interventions on patient outcomes and healthcare delivery. Generally, the literature on smart cities and AI constitutes a diverse and multi-disciplinary area of inquiry, covering various subjects and approaches. The usage of technological innovation, to socio-economic implications, is seen amongst the researchers in an investigation to understand how AI could shape the future of urban living to ensure sustainability, resilience, and inclusivity.

## METHODOLOGY & MODEL WORKING

To handle urban difficulties efficiently and effectively, the proposed CSMSC takes a comprehensive approach to using AI technology. The CSMSC allows smart city health and security events to be monitored, analyzed, and responded to in real time by consolidating data collecting, processing, and decision-making. CSMSC integrates sensors, data processing algorithms, and decision support mechanisms to improve urban living standards and advance smart city development to enable stakeholders to make timely and informed choices.

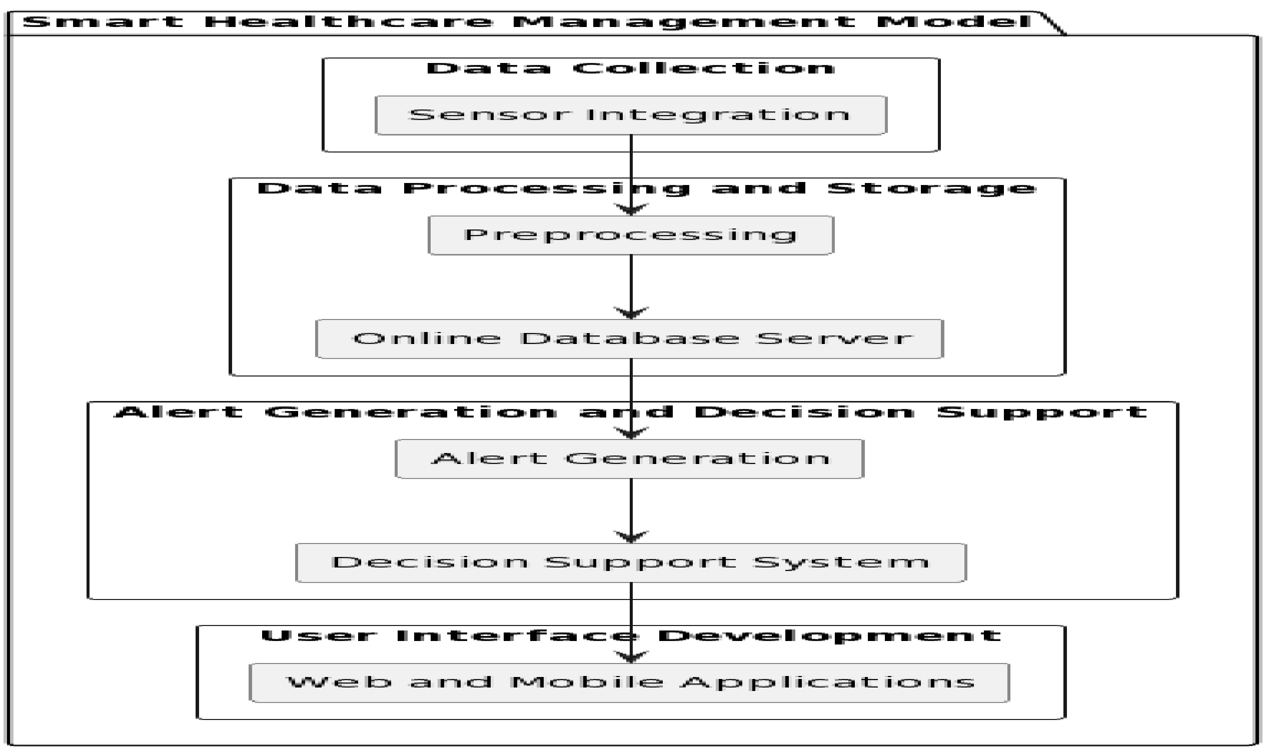



**Figure 1**
**Design and Sensor Integration**

### Design and Sensor Integration

- Selecting and integration of a list of sensors includes MLX90614 for temperature monitoring, HC-SR04 for distance, and an infrared object detector for object detection.
- Placement strategy ensuring complete health data capture.
- Continuous monitoring of temperature, distance, and an object's presence using built-in sensors.

### Data Processing and Storage

- Algorithms for data preprocessing are used to improve data.
- Securely store data in preprocessed form in the online centralized database server.
- Data preprocessing of raw sensor data to extract essential health information.
- Data analysis is preprocessed to find anomalies and patterns.

### Alert Generation and Decision Support

- Image contrast enhancement is implemented via a mean-squared error minimization algorithm.
- Implementation of alert generation mechanisms based on predefined thresholds or anomaly detection algorithms.
- Real-time generation of alerts on health conditions or security breaches anomalies.
- Stakeholder empowerment is enhanced through the integration of decision support systems.
- Give warnings to health workers and security personnel within the time so they can swiftly make informed decisions and actions.

### User Interface Development

- The interface of the system is friendly and interacts with the system.
- Web and mobile applications for data and alert accessibility.
- Stakeholders' interaction with live sensor data, alerts and results of analyses through the UI was enabled.
- Facilitation of informed decision-making and timely responses governed by the information presented.

This table shows how CSMSC's features stack up against the other models, making it easy to see how CSMSC excels in smart city management. CSMSC provides a high degree of adaptation to varied urban situations when comparing its properties to other models. Here, we will go over its flexibility and how it must be tailored to meet specific regional needs:

## COLLECTING DATA AND INTEGRATING SENSORS

CSMSC can monitor various factors important to diverse urban situations thanks to its integrating numerous sensors, such as object detectors, temperature, and distance. Object identification sensors, for instance, can aid in managing pedestrian and vehicular traffic in heavily crowded regions. In contrast, temperature monitoring sensors can aid in monitoring environmental conditions in industrial zones. Customization: The kinds and locations of sensors may be adjusted to meet the unique requirements and difficulties of each urban setting. More water level sensors, for example, may be installed in flood-prone coastal cities to monitor floods better.

# INFORMATION RETRIEVAL AND EVALUATION

CSMSC can respond locally to problems because of its data preparation methods and analytical skills, which allow it to derive useful insights from sensor data. Depending on the specific urban setting, CSMSC may tailor its analytic methodologies to discover air quality trends for pollution control or traffic pattern anomalies for congestion management. Local needs and priorities can inform the optimization of data pretreatment and analysis techniques. For example, cities with severe air pollution may have their air quality data analyzed more often, while older cities might have their structural health monitoring systems given greater priority.

**Table 1.**
**Model comparison**

| Authors | Year | Integration of Sensors and Data Collection | Perception & Analysis of Information | Centralized Data Storage & Processing | Alert Generation | Decision -Making Support |
|---|---|---|---|---|---|---|
| Sowmitha R. et al. | 2022 | ✓ | X | X | X | X |
| Z. Allam,et al | 2019 | X | X | X | X | X |
| Aritro De, et al | 2023 | X | ✓ | X | X | X |
| Dr A Mahesh Babu et al. | (2023). | X | X | ✓ | X | ✓ |
| H. Khan et al. | (2023). | X | X | X | X | X |
| Proposed model | 2024 | ✓ | ✓ | ✓ | ✓ | ✓ |

**Table 2.**
**Model comparison**

| Feature | CSMSC | Allam et al. | De et al. | Khan et al. |
|---|---|---|---|---|
| Integration of Sensors and Data Collection | ✓ (Temperature, Distance, Object) | X | X | X |
| Perception & Analysis of Information | ✓ (Data preprocessing, Analysis) | X | ✓ | X |
| Centralized Data Storage & Processing | ✓ (Centralized online database server) | X | X | X |
| Alert Generation | ✓ (Real-time alerts) | X | X | X |
| Decision-Making Support | ✓ (Decision support systems) | X | X | X |

## Processing and Storing Data

Regardless of the size or complexity of the urban environment, CSMSC's centralized data storage and processing capabilities provide effective handling of sensor data. Thanks to this integrated system, all stakeholders will have access to the data they need to make informed decisions. In order to meet the unique data storage and processing requirements of various metropolitan settings, the design of the central system may be modified. Offline data storage solutions, for instance, can be used to guarantee uninterrupted functioning in places with restricted internet access.

## Notification System and Decision Assistance

Responding quickly to new risks, such as public health crises or security concerns, is easier using CSMSC's decision support systems and real-time warning creation. Urban systems are made more resilient by CSMSC's timely observations and recommendations.

## Personalization

Various urban environments have various priorities and sensitivities. Thus, it is possible to modify the criteria for warning production and the design of decision support systems to accommodate them. Decision support systems can help prioritize evacuation routes and emergency response processes in cities vulnerable to natural catastrophes. While the Centralized System Model for Smart Cities (CSMSC) provides much flexibility to work in many urban settings, it shines when tailored to specific local needs. Maximizing the resilience and sustainability of cities around the globe is possible through the optimization of CSMSC through the customization of sensor integration, data processing algorithms, storage solutions, and decision support mechanisms to address unique urban concerns.

# RESULTS

**Integration of Sensors and Data Collection**: The model combined sensor technology to capture real-time environmental data. This guaranteed the accessibility of the current information for the following analysis and decision-making processes.

**Perception and Analysis of Information:** The model successfully analyzed the collected data Using sophisticated preprocessing techniques. It employed algorithms to derive relevant data, thus informing the decision-making process.

**Centralized Data Storage and Processing:** Data centralization was accomplished via MySQL database utilization. This centralized storage solution reduced data management, retrieval and processing time, thus improving the system's performance and scalability.

**Alert Generation:** Observing the data extracted from the analysis, the model autonomously produced alerts that notified the stakeholders about critical events or anomalies. This approach is proactive. It means it addresses risks and disruptions before they happen.

**Decision-Making Support**: The model gave strong decision-making support by comparing the data analyzed with the predefined criteria. This trait enabled stakeholders to make decisions in line with the strategic objectives and priorities of the organization.

**User Interface:** Visual Studio Windows Forms was the user interface for the model, which provided a friendly environment for user interaction and data visualization. This intuitive interface increased usability and accessibility by stakeholders of different areas. The polished outcomes underscore the effortless fusion of sensor technology, sophisticated data processing methods, centralized data management, proactive alert generation and robust decision-making support A provided by the model. Furthermore, the user-friendly interface, ease of use and access to the system for all the stakeholders guarantee higher effectiveness and efficiency.

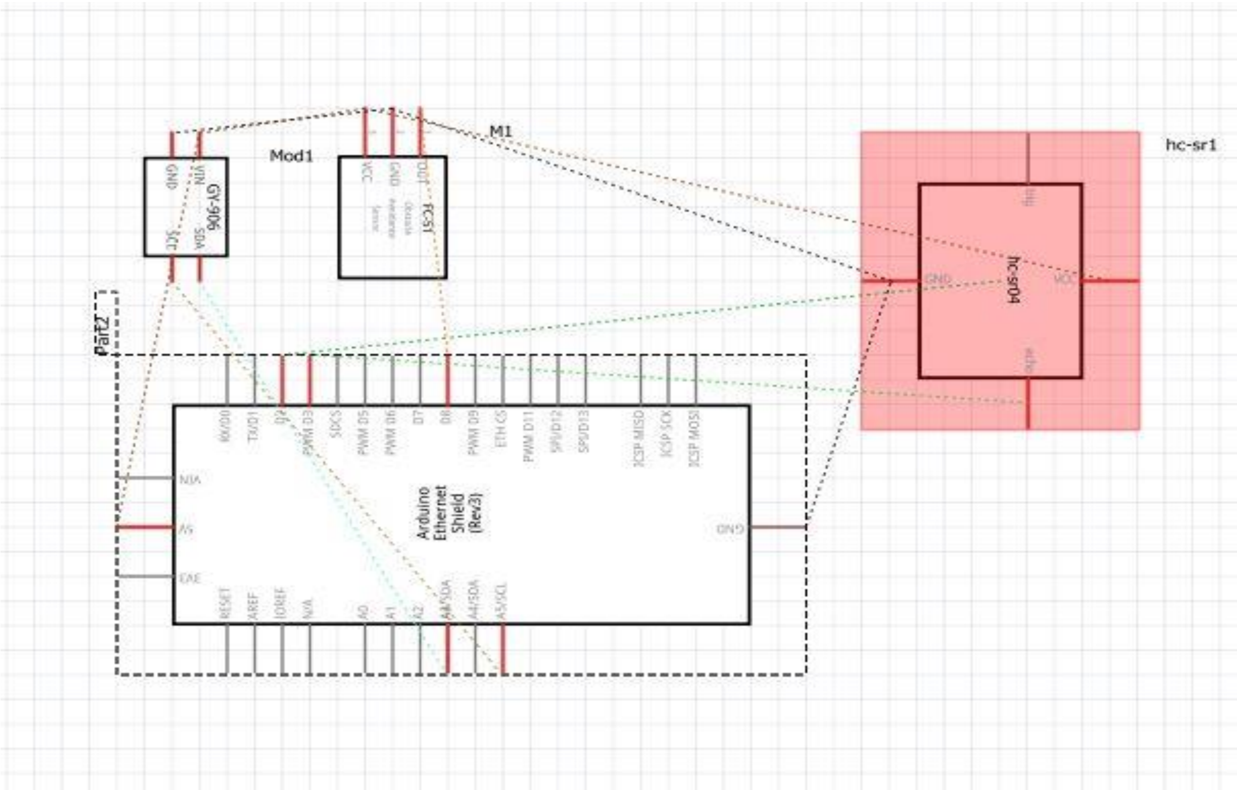



**Figure 1.**

**Figure 2.**

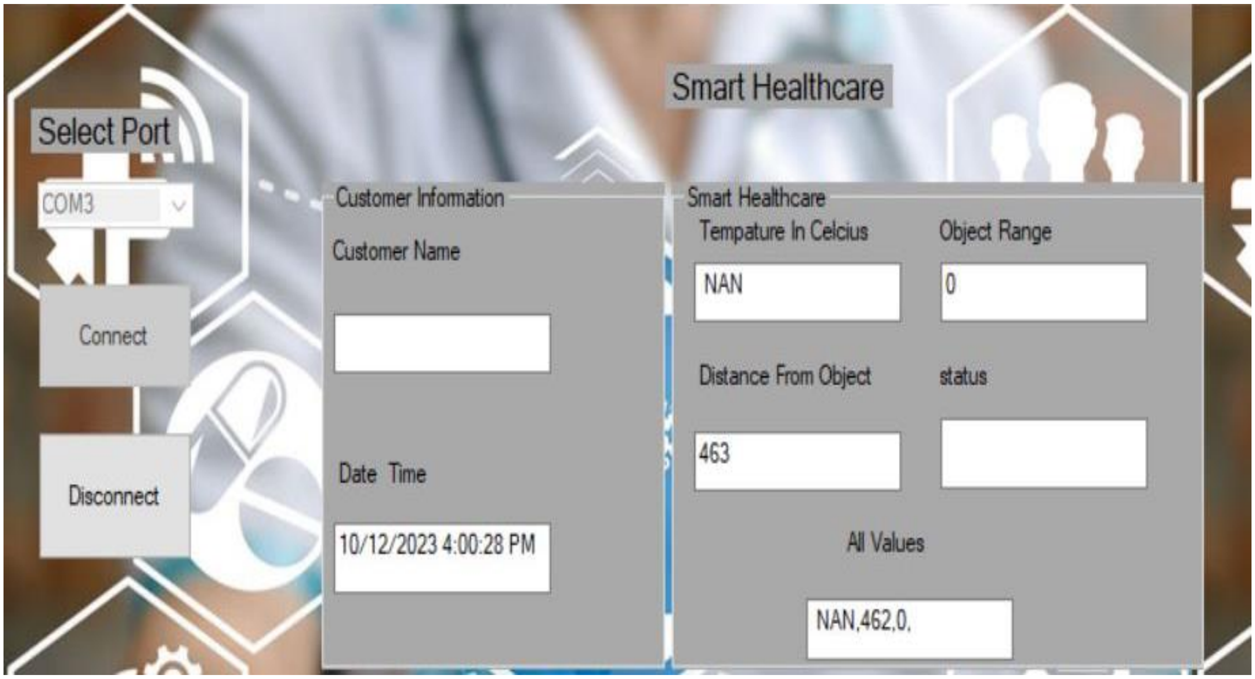



**Figure 2.**
**Mo del working diagram**

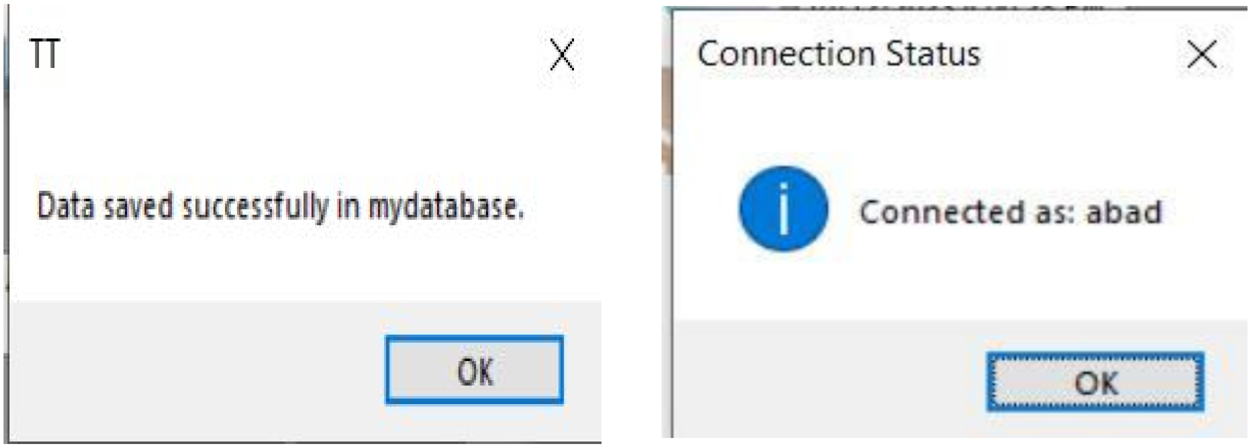



**Figure 3.**

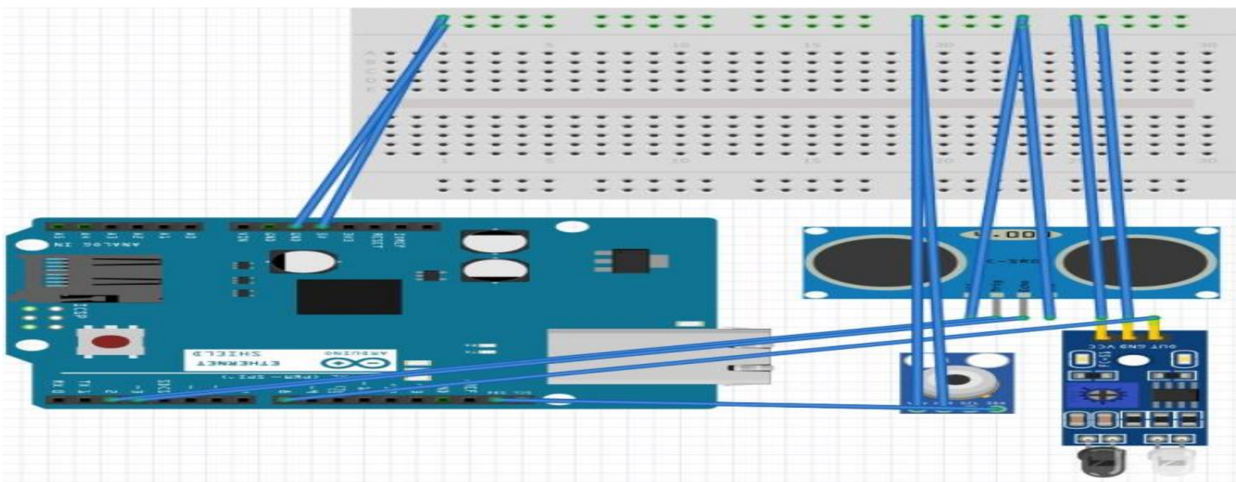
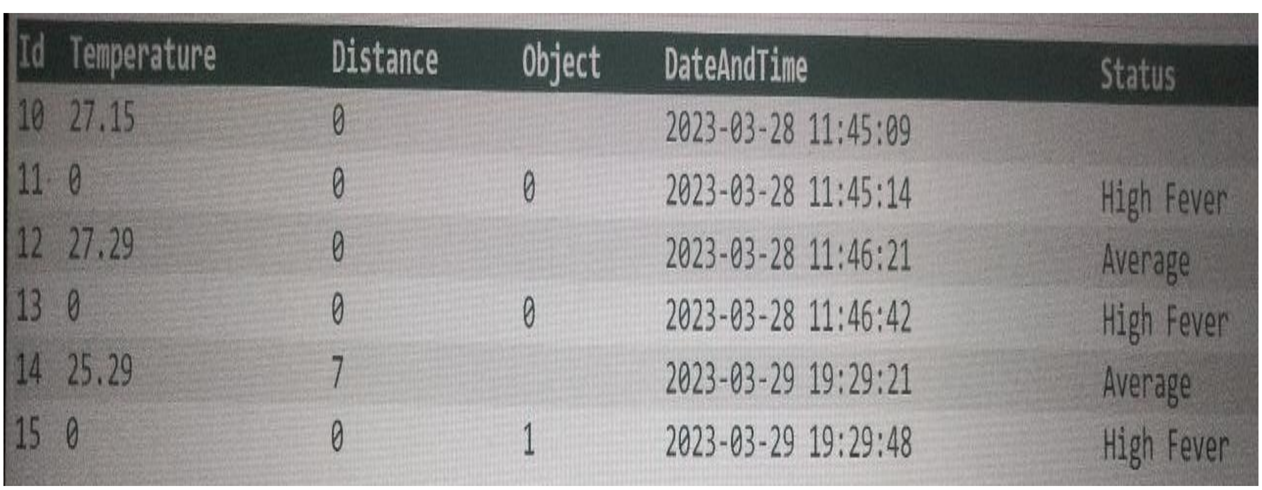


**Figure 4.**
**block Diagram connection representation**



| Id | Temperature | Distance | Object | DateAndTime | Status |
|---|---|---|---|---|---|
| 10 | 27.15 | 0 | | 2023-03-28 11:45:09 | |
| 11 | 0 | 0 | 0 | 2023-03-28 11:45:14 | High Fever |
| 12 | 27.29 | 0 | | 2023-03-28 11:46:21 | Average |
| 13 | 0 | 0 | 0 | 2023-03-28 11:46:42 | High Fever |
| 14 | 25.29 | 7 | | 2023-03-29 19:29:21 | Average |
| 15 | 0 | 0 | 1 | 2023-03-29 19:29:48 | High Fever |

**Figure 5.**


**Figure 6.**

## KEY FINDINGS OF CSMSC

By providing a unified framework for smart city administration, CSMSC speeds up data gathering, analysis, and decision-making. Improved urban sustainability and resilience are outcomes of the model's real-time monitoring and alarm-generating capabilities, allowing rapid responses to new urban concerns. Stakeholders are empowered to make educated decisions and proactive actions using CSMSC's user-friendly interface and decision support technologies, increasing the quality of life in smart cities. Finally, the Centralized System Model for Smart Cities (CSMSC) offers a fresh approach to meeting the changing demands of smart city development. CSMSC's integration of sensors, data processing algorithms, and decision support systems improves urban efficiency, responsiveness, and quality of life.

## DISCUSSION

The Citywide System Model for Smart Cities (CSMSC) is a promising approach to urban management and governance complexities in an era of rapid urbanization and technological advancement. The discourse goes deeper by combining the implications, challenges, and future directions of implementing CSMSC, gleaned from various research papers. One of the major strengths of the CSMSC is its capacity to integrate diverse data sources into one centralized platform, thus providing holistic urban insights and evidence-based decision-making through sensor networks and AI algorithms. CSMSC provides real-time monitoring and analysis functionality, enabling proactive solutions to urban issues. This centralized approach, therefore, helps improve efficiency and resource allocation, enhancing urban resilience and sustainability. Nevertheless, the realization of the CSMSC does bear difficulties. The fusion of heterogeneous data sources and AI algorithm interoperability presents technical barriers that must be overcome. Besides, due to privacy, security, and ethical concerns, data governance mechanisms need to facilitate the transparency and accountability of data governance practices.

In addition, the scalability and adaptability of CSMSC to different urban contexts merits attention. The model has the potential to deal with common urban problems, but its effectiveness could differ depending on the local setting, infrastructure, and socio-economic factors. Hence, future studies should focus on tailoring and specializing the CSMSC to fit the unique requirements of different cities and communities. Although these challenges exist, CSMSC represents a tremendous stride towards creating intelligent and adaptive cities. The AI technologies employed by CSMSC can centralize data management and decision-making processes, transforming urban governance and improving the quality of life for urban residents. Going forward, researcher-policymakers-urban stakeholders' ongoing alliance is critical to unravelling the whole CSMSC potential and dealing with the plurality of challenges confronting cities in the 21st century.

## CONCLUSION

The fusion of insights from various research works points to the tremendous transformative power of the Centralized System Model for Smart Cities (CSMSC) in meeting modern-day urban challenges. The CSMSC integrates and streamlines data acquisition, processing, and decision-making processes through sensor networks and AI algorithms, thereby providing a holistic management and governance approach for urban areas. Usingsynthesising already existing sources of information, this paper has highlighted the main components and aspects of CSMSC function. CSMS creates operational efficiency and fosters proactive responses to urban challenges; thus, it enhances urban resilience, sustainability, and livability.CSMSC, as a new and impressive paradigm towards smart city development, possesses several obstacles which must be considered for success. Technology complexities, privacy data issues, and the requirement for strong governance systems to secure openness and responsibility are some of them. For the future, more research and collaboration among all stakeholders are essential to make CSMSC conform to each city's needs and context of each solving these difficulties using the transformational ability of centralized AI systems in CSMSC; it will provide smart, sustainable and resilient cities that can be lived in the future.

## DECLARATIONS

**Acknowledgement:** We appreciate the generous support from all the supervisors and their different affiliations.

**Funding:** No funding body in the public, private, or nonprofit sectors provided a particular grant for this research.

**Availability of data and material:** In the approach, the data sources for the variables are stated.

**Authors' contributions:** Each author participated equally to the creation of this work.

Conflicts of Interests: The authors declare no conflict of interest.

**Consent to Participate:** Yes

**Consent for publication and Ethical approval:** Because this study does not include human or animal data, ethical approval is not required for publication. All authors have given their consent**.**

## REFERENCES

Al Ridhawi, I., Otoum, S., Aloqaily, M., & Boukerche, A. (2021). Generalizing AI: Challenges and Opportunities for Plug and Play AI Solutions.

Alaeddini, M., Hajizadeh, M., & Reaidy, P. J. (2023). A Bibliometric Analysis of Research on the Convergence of Artificial Intelligence and Blockchain in Smart Cities.
Ashwini, B. P., Savithramma, R. M., & Sumathi, R. (2022). Artificial Intelligence in Smart City Applications: An overview.
Badidi, E. (2022). Edge AI and Blockchain for Smart Sustainable Cities: Promise and Potential.
Babu, A. M., Akhil, B., & Pochampally, N. K. (2023). Smart Cities and Intelligent Transport Systems.
Cabrera, C., Svorobej, S., Palade, A., Kazmi, A. H., & Clarke, S. (2023). MAACO: A Dynamic Service Placement Model for Smart Cities.
Dash, B., & Sharma, P. (2022). Role of Artificial Intelligence in Smart Cities for Information Gathering and Dissemination (A Review).
De, A., Raj, A., Rana, D., Anand, P., Sharma, S., Seth, V., & Sugga, P. S. (2023). Smart Cities Mission: Promises & Performance: The Environmental Sustainability of Smart Cities in India.
Ghazal, T. M., Hasan, M. Z., Alshurideh, M., Alzoubi, H. M., Ahmad, M., Akbar, S. S., Kurdi, B., & Akour, I. A. (2021). IoT for Smart Cities: Machine Learning Approaches in Smart Healthcare - A Review.
González, R., Ferro, R., & Liberona, D. (2020). Government and governance in intelligent cities, smart transportation study case in Bogotá Colombia.
Gupta, A., Gupta, S., Memoria, M., Kumar, R., Kumar, S., Singh, D., Tyagi, S., & Ansari, N. (2022). Artificial Intelligence And Smart Cities: A Bibliometric Analysis.
Javed, A. R., Ahmed, W., Pandya, S., Maddikunta, P., Alazab, M., & Gadekallu, T. (2023). A Survey of Explainable Artificial Intelligence for Smart Cities.
Khan, H., & Nazir, S. (2023). Assessing the Role of AI-Based Smart Sensors in Smart Cities Using AHP and MOORA.
Kuberkar, S., Singhal, T., & Singh, S. (2022). Fate of AI for Smart City Services in India.
Liu, X., Tamminen, S., Tarkoma, S., & Su, X. (2022). Trustworthy Distributed Intelligence for Smart Cities.
Liu, Y., & Yang, K. (2022). Communication, sensing, computing and energy harvesting in smart cities.
Nikitas, A., Michalakopoulou, K., Njoya, E., & Karampatzakis, D. (2020). Artificial Intelligence, Transport and the Smart City: Definitions and Dimensions of a New Mobility Era.
Peng, W., Gao, W., & Liu, J. (2019). AI-Enabled Massive Devices Multiple Access for Smart City.
Rai, K. M., & Vijayalakshmi, S. (2023). The Role of Information and Communication Technology in Smart City.
Raptis, T. P., Cicconetti, C., Falelakis, M., Kalogiannis, G., Kanellos, T., & Lobo, T. (2023). Engineering Resource-Efficient Data Management for Smart Cities with Apache Kafka.
Singh, S., Sharma, P., Yoon, B., Shojafar, M., Cho, G., & Ra, I. (2020). Convergence of blockchain and artificial intelligence in IoT network for the sustainable smart city.
Sleem, A., & Elhenawy, I. (2023). Survey of Artificial Intelligence of Things for Smart Buildings: A Closer Outlook.
Sowmitha, R., Raju, S. S., H. R., Arjuna, S., & Kumar, C. R. (2022). Artificial Intelligence in Smart Cities and Healthcare.
Șerban, A., & Lytras, M. D. (2020). Artificial Intelligence for Smart Renewable Energy Sector in Europe—Smart Energy Infrastructures for Next Generation Smart Cities.
Teredesai, A. (2023). Social Public Health Infrastructure for a Smart City Citizen Patient: Advances and Opportunities for AI-Driven Disruptive Innovation.
Ullah, Z., Al-turjman, F., Mostarda, L., & Gagliardi, R. (2020). Applications of Artificial Intelligence and Machine learning in smart cities.
Ullah, Z., Al-turjman, F., Mostarda, L., & Gagliardi, R. (2020). Applications of Artificial Intelligence and Machine learning in smart cities.
Yigitcanlar, T., Butler, L., Windle, E., Desouza, K., Mehmood, R., & Corchado, J. (2020). Can Building "Artificially Intelligent Cities" Safeguard Humanity from Natural Disasters, Pandemics, and Other Catastrophes? An Urban Scholar's Perspective.

Yigitcanlar, T., Desouza, K., Butler, L., & Roozkhosh, F. (2020). Contributions and Risks of Artificial Intelligence (AI) in Building Smarter Cities: Insights from a Systematic Review of the Literature.

Yigitcanlar, T., Kankanamge, N., & Vella, K. (2020). How Are Smart City Concepts and Technologies Perceived and Utilized? A Systematic Geo-Twitter Analysis of Smart Cities in Australia.

Yigitcanlar, T., Mehmood, R., & Corchado, J. (2021). Green Artificial Intelligence: Towards an Efficient, Sustainable and Equitable Technology for Smart Cities and Futures.

Yang, L., Liu, Z., Zhang, S., Yue, Q., & Li, F. (2021). Research on Innovation of Urban Combat Equipment Support Model Based on Smart City and Artificial Intelligence.

Allam, Z., & Dhunny, Z. A. (2019). On big data, artificial intelligence and smart cities.