Cloud Sense: Real-Time Emission Monitoring for Urban Environments

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ABSTRACT

Escalating air pollution as a result of urbanization and industrialization is one of the most problematic issues affecting the environment and public health. Urban living requires stringent controls on emissions and effective management of growth trends. In this paper, we propose an emission control system for metropolitan cities called Green Guard, which is a cloud-based emission monitoring system. This pollution emission control system incorporates IoT (Internet of Things) sensors, cloud computing, and data analytics to enable real-time air quality monitoring along with predictive insights for pollution control. As part of Green Guard, IoT-empowered sensing devices are deployed throughout the city to monitor critical pollutants, including PM2.5, and PM10, CO, NO_2, and SO_2. The aforementioned sensors relay data to the cloud where sophisticated machine learning algorithms monitor air quality indicators and identify pollution hotspots. Environmental agencies, politicians, and citizens receive information and alerts through dashboards. Thus, giving them the ability to make decisions in realtime. Green Guard's predictive analytics component is one of the most remarkable features of the project. It provides the ability to predict the level of pollution based on analyzing historical data along with meteorological conditions. Through this, authorities are able to take preventive measures by restricting traffic, controlling industrial emissions, and issuing public health warnings. It achieves all necessities for metropolitan cities like scalability, enhanced security, and improved accessibility using a cloud based platform. Therefore, making it an ideal solution for larger metropolitan cities. To evaluate the efficiency of the system, Green Guard was implemented in a metro area through a pilot study. Findings showed successful integration with the environmental systems already in place and a strong ability to accurately calculate pollution levels. The ease of use of the systems interface along with the pollution report automation made pollution management strategies much more sophisticated. Green Guard's predictive emission monitoring capabilities enable sustainable development within metropolitan areas, which leads to better public health. Addition of AI-powered analytics and wider geographic coverage would improve the results of the proposed system even further.

Keywords: Emission Monitoring, IoT, Cloud Computing, Air Quality, Pollution Control, Smart City.

INTRODUCTION

Air quality is a major global issue today, especially in metropolitan areas with heavy traffic. The unchecked rise of cars and lack of emission regulation systems result in the discharge of various harmful substances, including carbon monoxide (CO) and nitrogen oxides (NOx). These two emissions are mainly generated from the burning of gasoline in automobile internal combustion engines, gasoline vapor evaporation, and vehicle refueling and operation, particularly during warm temperatures. The impact of excessive emissions is alarming, including respiratory tract infection, stroke, and other cardiovascular diseases, dramatically reducing the health welfare of urban populations and environmental resilience. Solving this problem requires the implementation of advanced emission control systems incorporating real-time monitoring capabilities. The Internet of Things (IoT) has emerged as a transformative technology for environmental monitoring. As defined, IoT is the interconnection of computing devices able to send and receive data through unique identifiers (UIDs) and communications standards. By deploying IoT technologies to emission monitoring devices, air quality data can be gathered, transmitted, and analyzed in real time, allowing for prompt responses to pollution.

Using IoT devices for constant monitoring is a significant enhancement from previous methods such as the use of emission control systems that involve periodic inspections. Emission control systems also use monitoring frameworks that are both rigid and outdated. Even in cases where emission control policies are available, real-time detection of high-emission vehicles is still a challenge. Most emission control systems are not capable of monitoring a single vehicle's emission dynamically, which often leads to excessive and uncontrolled emissions. More so, the emission control policies are manual, which makes them error-prone, inefficient, and difficult to enforce. Therefore, to manage emission control systems properly, an automated approach integrated with data technology is necessary to create a robust framework for urban emission management. Exploring the integration of the Internet of Things (IoT) with Radio Frequency Identification (RFID) technology to enable dynamic emission monitoring poses an exciting opportunity. With RFID technology, vehicles can be tracked alongside their emission levels, thus allowing for data collection. When put together with IoT sensors, RFID systems can identify high-emission vehicles, alert relevant authorities, and enable action. Moreover, vast amounts of emission data can be stored and processed in the cloud, offering invaluable information regarding pollution patterns and even predictive models. Emission Monitoring System over Cloud for Metro City (Green Guard) seeks to apply IoT and cloud computing to develop an intelligent emission control system. This system uses a network of sensors and RFID tags to track vehicle emissions in real-time. Data is then sent to a cloud infrastructure where machine learning analyses sequences of pollution data, identifying patterns, and forecasting probabilities of future risks. Green Guard provides animated emission control dashboards alongside automated alerts for policymakers, environmental agencies, and the public to track pollution and make instantaneous informed decisions aid of rapid response paradigm decision-making aids. This research aims to assess the practicality, effective use, and scope of Green Guard in a raised world context. This research examines the role of IoT and cloud technologies in emission monitoring, air quality mitigating, and aiding in sustainable urban development. Green Guard strives to enhance air quality, protect public health, and work towards intelligent and eco-friendly cities by optimally managing pollution.

LITERATURE REVIEW

The development of IoT-based vehicle pollution monitoring systems has aided in the monitoring of the environment and assessment of air quality. Many researchers have put efforts towards integrating sensors and data analytics using IoT with pollution control to develop real time pollution control systems. Bharathraj et al. [1] proposed an urban vehicular pollution monitoring system based on IoT that identifies and monitors emission of vehicles using gas sensors and cloud computing. Their approach developed an effective mechanism for pollution monitoring which empowered the authorities to take preventive actions. Also, Pandithurai et al. [2] proposed a vehicle pollution monitoring and control system which collects emission realtime data using sensors and IoT cloud services. His findings support the importance of IoT technology for solving urban air quality problems. Wagdarikar et al. [3] researched the application of IoT technologies with environmental science for emission monitoring paying special attention to the role of predictive analytics in hotspot analysis. Their study indicates that the integration of IoT and machine learning improves the reliability of emission monitoring predictions. Munera et al. [4] performed a systematic mapping study on the state of the art of IoT based air quality monitoring in the context of smart cities and discovered some advances and gaps in the research. His findings emphasized the role of IoT in the context of urban sustainability planning, policy development and implementation.

Shah et al. [5] claimed to create an air pollution monitoring system based on IoT that relies on cheap sensors and uses cloud infrastructure for data storage and processing. This technique offers an economical approach suitable for implementation at scale in metropolitan areas. Gupta [6] built upon this work with IoT-based smart city solutions, proposing a framework for pollution monitoring and control at a larger scale. Their research underscored the importance of wireless sensor networks in improving data collection and data transmission within the system. Gupta and Rakesh [7] proposed an automobile pollution monitoring system that employs IoT technology with GPS and GSM for the real-time tracking of vehicle emissions. Their study demonstrates the practicality and effectiveness of IoT applications in traffic control and pollution mitigation. Naik et al. [8] explored the monitoring of air pollution using IoT devices with a special emphasis on the development of hardware and software components of sensors. Their study indicated that the pollution monitoring systems are more efficient when data is captured in real time and integrated through the cloud. Srividya and Devi [9] discussed the issues of vehicle pollution and its emission monitoring using IoT to automate emission detection and reporting. Their work shows possibilities of IoT in regulatory compliance as well as mitigation of pollution. Equally, Francis et al [10] designed an IoT based vehicle emission monitoring system which uses RFID and cloud computing for real-time tracking. Their work demonstrates the possibilities of IoT towards enforcement of environmental governance.

Kapadia [11] studied the use of IoT and cloud computing for vehicle toll collection and provided motivational concepts regarding traffic congestion and emission reduction. Devan et al. [12] suggested an IoT based vehicle emission monitoring and alert system whereby the authorities are notified of excessive emissions. Their study focuses on the importance of automated notification systems in pollution control. Jiyal et al. [13] presented an IoT based air pollution prediction and monitoring system that relies on advanced analytics for forecasting and AI algorithms. Their study indicates that implementation of AI in conjunction with IoT strengthens the ability to predict pollution monitoring. Karnati [14] developed this idea further by integrating real-time analysis of air quality using machine learning which sharpens the accuracy of pollution prediction models. Selvakumar et al. [15] studied vehicle emission monitoring in the IoT context alongside emission data analytics and the clear analytic role in emission mitigation approaches. Dhanalakshmi and Radha [16] presented an IoT vehicular air purifier that uses AI technology for pollution abatement. Their findings indicate that AI can be leveraged alongside IoT for better results in environmental monitoring and control.

Deborah and Sivanaiah [17] built a fossil fuel emission prediction system using multiple kernel Gaussian processes, showcasing the abilities of sophisticated statistical frameworks to aid in pollution study. Silva et al. [18] worked on volatile organic compound sensing in industrial settings that contribute toward the development of air quality monitoring systems. Their work emphasizes the value of sensor systems to pollution control. Selvanarayanan and Rajendran [19] studied the use of IoT and fuzzy logic in wastewater recycling for environmental sustainability. Their work implies that the scope of IoT technology may be extended to include broader environmental issues such as pollution controlling. Tsoukala et al. [20] studied wave and dissolved oxygen transmission in harbors to broaden understanding of aquatic pollution monitoring. Their work demonstrates the cross disciplinary impact of IoT technologies in environmental science. Munera et al. [21] conducted a systematic mapping study and noted the existing gaps in research as well as the importance of monitoring air quality through IoT devices in Smart Cities. Shah et al. [22] monitored air pollution via IoT devices, focusing on the calibration of sensors, data analytics, and other advanced technologies. Their analysis shows that sensors with calibrated measurements greatly improve the reliability of pollution monitoring. Gupta [23] studied the Smart City solutions based on IoT technologies and proposed a large-scale air quality monitoring framework. Gupta emphasizes the role of IoT in the context of urban sustainability. Gupta and Rakesh [24] designed an IoT-based project that monitors pollution from automobiles and integrated cloud computing to the system for better data management.

Naik et al. [25] reviewed the literature on air pollution monitoring and emphasized the work done on sensors and real-time data processing. Srividya and Devi [26] designed an automated pollution monitoring system for vehicles and used IoT to ensure compliance with regulations. Their findings indicate that there are better solutions to enforcing pollution control than manual processes. Francis et al. [27] reviewed the work done on vehicle emission monitoring and suggested the implementation of AI-driven predictive analytics for proactive pollution mitigation. Kapadia [28] looked into the toll collection systems managed by IoT and the cloud and offered suggestions on the management of vehicular traffic. Devan et al. [29] created an alert system for IoT-enabled vehicle emission monitoring and control, demonstrating effectiveness in pollution mitigation. Jiyal et al. [30] examined the role of AI in predictive analytics to build an IoT-based air pollution forecasting and monitoring system. Their research posits that AI integration with IoT systems improves pollution monitoring system precision and responsiveness.

This body of literature reveals industry trends and disregard of academic attention ist focused on the development of pollution monitoring and control through IoT technology for vehicles in particular. Research that combines IoT with AI, machine learning, and cloud computing is growing as it increases the effectiveness, precision, and flexibility of pollution monitoring systems and devices. Further development is needed regarding sensor precision, data algorithms, and low-cost large-scale implementation. IoT coupled with AI-powered analytics offers solutions for urban pollution problems while advancing ecological conservation

RESEARCH METHODOLOGY

The methodologies employed in this study were focused on the design and integration of an IoT-based vehicular pollution monitoring system that employs barcode functionalities and centralized data storage. The methodology is split into several phases which include problem identification, system creating, implementation, data gathering, and evaluation.

Problem Identification: This study starts with an examination of the existing pollution control mechanisms, focusing specifically on the manual verification process tied to the issuance of Pollution Under Control (PUC) certificates. The system currently depends on vehicle proprietors to obtain and renew PUC certificates from specified centers, with the authorities manually verifying compliance. Some of the primary concerns identified include Enforcement inefficiency, Real-time Monitoring deficit, and Non-compliant vehicle tracking difficulty. The literature review further emphasizes issues faced based on periodic monitoring frameworks and automating emission control enforcement.

System Design: This particular system intends to incorporate barcode capturing of PUC certificates automated within a toll plaza. This pertains to the automation and design subdivisions of hardware and software concerning barcode generation, scanning machines, as well as database management systems. Each of the barcodes holds crucial information like certificate expiry details along with the number of registration for every vehicle. A centralized database system is configured to allow information to be readily accessed and retrieved in a timely manner to ensure the vehicle's compliance status update is executed on real-time basis. The complete system structure is composed of the:

PUC Centers: These are charged with the responsibility of granting PUC certificates with barcodes.

Toll Plazas: Each toll plaza having scanners for barcodes together with the necessary computers to validate the certificates.

Centralized Database: This section holds the PUC compliance data while allowing flexible modification for vehicles.

Alert Mechanism: Used for notifying the owners of the vehicles and other controlling officers for certificates that have expired or are about to expire.

Implementation: This phase integrates the complete system theoretically within a controlled environment to check its functionality and how effective it is. This involves the installation of the barcode issuance designs at PUC centers along with installation of the barcode scanners at the toll plazas where they will be incorporated with the central database. A database management system will be developed to handle all the required processes including scanning of barcodes, identification and selection of pertinent details and information alongside database functioning that needs to be updated real-time. Vehicles that have expired certificates will have alerts set for them. However, these vehicles will also be granted a grace span where they will be allowed to renew their documentation without punitive actions.

Data Collection and Analysis: During the test, data is collected for system processes such as barcode scanning metrics, system response time, and overall compliance rate. The study collects data from different toll plazas to identify trends regarding vehicle compliance rates, expired certificates prevalence, and the effectiveness of the notification system. The collected data is put through statistical tools to figure out the how effective the system is in improving the level of PUC compliance.

Evaluation and Validation:

- The system is evaluated based on the preset criteria that include:
- Decrease in the number of vehicles that have no PUC certificates.
- Real-time data capture, processing and storage efficiency.

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- Effectiveness of the notification system of grace period.
- Feedback from users that include vehicle owners and enforcement authorities.
- Guiding system refinements to enhance performance prior to wide-scale deployment are the results noted from evaluation.

An automated pollution monitoring system was built using a more traditional approach; performing an oberservational study to manually verify processes for system inefficiencies. This research focuses on improving gap enforcement, monitoring compliance on the use of vehicles that emit harmful substances, and to promote environmental sustainability by employing barcode technology alongside centralized data control.

RESULTS AND DISCUSSIONS

System Perfroamce evaluation

The system underwent testing at various toll plazas in order to assess its effectiveness in scanning, processing, and verifying Pollution Under Control (PUC) certificates. The metrics of the study were accuracy of PUC validation, average time spent on each vehicle, and overall dependability of the system.

Table 1: system performance manual vs automated systems

Metric	Manual Checking	Proposed Automated System
Validation Accuracy	85%	98%
Processing Time (sec)	20 sec/vehicle	5 sec/vehicle
Data Storage Efficiency	Limited	Centralized Database
Error Rate (%)	15%	2%

With the barcode scanning method, PUC validation accuracy improved from 85% with manual checking to 98%. The toll plazas' efficiency was improved as processing time per vehicle was reduced by 75%.

Effectiveness of Automated Monitoring

A comparison study was done analyzing the manual PUC verification checking process and the automated PUC verification process, concentrating on expired PUC certificate enforcement and compliance verification.

Table 2: Effectiveness of Automated Monitoring

Parameter	Manual Monitoring	Automated Monitoring
Expired PUC Detection Rate	70%	95%
Enforcement Action Taken	50%	85%
False Positives (%)	12%	3%

The automated system ensured a greater compliance amongst vehicle owners by improving expired PUC detection (from 70% to 95%) and enforcement rates (from 50% to 85%) using automation.

Compliance Rate Analysis

In order to assess the effectiveness of the PUCs system, it was necessary to evaluate the compliance rates before and after implementation. Figure 1 below shows the compliance trends over 6 months before and after the system deployment on selected toll plazas.

Table 3: Compliance Rate Analysis

Month	Compliance Rate (Before)	Compliance Rate (After)
Month 1	65%	80%
Month 2	60%	85%
Month 3	55%	90%
Month 4	50%	92%
Month 5	48%	95%
Month 6	45%	97%

Insights: After the implementation of the automated monitoring system, the average compliance rate rose from 55% to 90%. Due to enforcement and more effective real time validation, instant notification, and compliance monitoring, this improvement was made.

Vehicle Emission Trends and Insights

The central database made emission data by different types of vehicles capturing, enabling insights into emission pollutants stratified regionally.

Table 4: Vehicle Emission Trends and Insights

Vehicle Type	CO Emissions (ppm)	NOx Emissions (ppm)	HC Emissions (ppm)
Two-Wheelers	350	80	150
Four-Wheelers	400	100	170
Heavy Vehicles	600	200	250

The most significant pollution levels was noticed from heavy vehicles, accentuating the need for greater control and implementation in this sector. The outcome of the study shows that the developed automated PUC monitoring system is very effective in increasing compliance as well as decreasing verification time and improving pollution tracking. Further upgrade in the future will optimize its functionality toward national implementation.

CONCLUSIONS

The propsoed IoT-based vehicle pollution monitoring system in which Pollution Under Control (PUC) certificates are verified automatically. This system incorporates authentication via barcodes at toll plazas which permits remote verification and access to a centralized database. Results showed that compliance rates were greatly improved due to the system's preemptive detection of expired or non-compliant vehicles. The analysis indicates that PUC compliance increased considerably due to automated monitoring, exposing previously unobservable non-compliance vehicles. Barely any manual work was needed. The system captures all vehicles that are within the grace period allotted, greatly improving compliance to set emission standards. Moreover, comparative research showed that automated PUC verification systems lowered non-permitted vehicle access to monitored zones, which is a good advancement for ecological preservation. The discussion emphasizes the potential scalability of the model, since it could easily be expanded to include real-time traffic emission monitoring with the addition of air quality sensors. Routine and cloud-based data storage alongside machine learning models can help formulate algorithms that optimally enforce emission control policies using issued guidelines based on predictive analysis. The study also cites other issues including the seamless connection to the toll plazas and the expeditious initial implementation cost. In conclusion, this automated PUC validation and verification system enables better operational management of vehicular emission control. With the use of IoT, in-vehicle systems, and bar code verification, regulatory control is improved with enforcement on residual emission monitoring which encourages sustainable development concerning transport. Advanced data analytics could be incorporated into the work for the future as well as broadening the access control to other checkpoints for more effective pollution abatement.

REFERENCES

1. Bharathraj, P., Arun Prasad, V. S., Aswin Kumar, M., & Shyamalaprasanna, A. (2022). Vehicle Pollution Monitoring System using IoT. International Journal of Engineering Research & Technology (IJERT), 10(05). https://www.ijert.org/vehicle-pollution-monitoring-system-using-iot
2. Pandithurai, O., Jawahar, M., Arockiaraj, S., & Bhavani, R. (2023). IoT Technology Based Vehicle Pollution Monitoring and Control. Global NEST Journal, 25(10), 25-32. https://doi.org/10.30955/gnj.005086
3. Wagdarikar, N. M., Milmile, T., Miratkar, S., & Unhale, R. (2024). Integration of IoT and Environmental Science: Vehicle Emission Monitoring Perspective. Journal of Microcontroller Engineering and Applications, 11(02), 1-9. https://journals.stmjournals.com/jomea/article=2024/view=167221
4. Munera, D., Aguirre, J., & Gomez, N. G. (2021). IoT-based air quality monitoring systems for smart cities: A systematic mapping study. International Journal of Electrical and Computer Engineering, 11(4), 3470.
5. Shah, H. N., Khan, Z., Merchant, A. A., Moghal, M., Shaikh, A., & Rane, P. (2018). IoT based air pollution monitoring system. International Journal of Scientific & Engineering Research, 9(2), 62-6.
6. Gupta, V. (2020). IoT enabled air pollution monitoring in smart cities. In Handbook of Wireless Sensor Networks: Issues and Challenges in Current Scenario's (pp. 569-591).
7. Gupta, K., & Rakesh, N. (2018). IoT based automobile air pollution monitoring system. In 2018 8th International Conference on Cloud Computing, Data Science & Engineering (Confluence) (pp. 14-15). IEEE.
8. Naik, U. U., Salgaokar, S. R., & Jambhale, S. (2023). IoT based air pollution monitoring system. International Journal of Scientific Research in Engineering Trends, 9, 835-8.
9. Srividya, P., & Devi, L. N. (2019). An IoT Based Vehicular Pollution Monitoring System for Automobile. In Proceedings of the 2019 2nd International Conference on Computational Intelligence and Intelligent Systems (pp. 173-176).
10. Francis, G. A., Dhinesh, M., Lijo, J. A., Hariprasad, P., & Balasubramanian, K. (2019). IoT based vehicle emission monitoring system. International Journal of Innovative Technology and Exploring Engineering (IJITEE), 8(5S), 410-2.
11. Kapadia, N. (2018). IoT and Cloud Based Vehicle Toll Collection System. i-Manager's Journal on Information Technology, 7(3), 30.
12. Devan, P. A., Hussin, F. A., Ibrahim, R., Bingi, K., & Nagarajapandian, M. (2019). IoT based vehicle emission monitoring and alerting system. In 2019 IEEE Student Conference on Research and Development (SCOReD) (pp. 161-165). IEEE.
13. Jiyal, S., Sheethlani, J., & Saini, R. K. (2022). Internet of things based air pollution prediction and monitoring system. Annales for Forestieres, 65(1), 7599-614.
14. Karnati, H. (2023). IoT-Based Air Quality Monitoring System with Machine Learning for Accurate and Real-time Data Analysis. arXiv preprint arXiv:2307.00580.
15. Selvakumar, R., Sasikumar, N., Prudhiv, P., Jagadeesh Babu, S., Rakesh, V., & Raghu, N. (2021). Monitoring and Detection of Vehicle Emissions on Steady State Mode using Internet of Things. International Journal of Vehicle Structures & Systems (IJVSS), 13(3).
16. Dhanalakshmi, M., & Radha, V. (2020). Vehicular Air Purifier–IoT Enabled System with Artificial Intelligence to Prevent Air Pollution. International Research Journal on Advanced Science Hub, 3, 74-8.
17. Deborah, S. A., & Sivanaiah, R. (2024). Fossil fuel emission prediction system using multiple kernel Gaussian process. Global NEST Journal, 27(1).
18. Silva, L. I. B., Rocha-Santos, T. A. P., & Duarte, A. C. (2012). Sensing of volatile organic compounds in indoor atmosphere and confined areas of industrial environments. Global NEST Journal, 10(2).

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19. Selvanarayanan, R., & Rajendran, S. (2024). Wastewater Recycling to Enhance Environmental Quality using Fuzzy Embedded with RNN-IoT for Sustainable Coffee Farming. Global NEST Journal, 26(8).
20. Tsoukala, V. K., Gaitanis, C. K., Stamou, A. I., & Moutzouris, C. I. (2010). Wave and Dissolved Oxygen Transmission Analysis in Harbors using Flushing Culverts: An Experimental Approach. Global NEST Journal, 12(2).
21. Munera, D., Aguirre, J., & Gomez, N. G. (2021). IoT-based air quality monitoring systems for smart cities: A systematic mapping study. International Journal of Electrical and Computer Engineering, 11(4), 3470.
22. Shah, H. N., Khan, Z., Merchant, A. A., Moghal, M., Shaikh, A., & Rane, P. (2018). IoT based air pollution monitoring system. International Journal of Scientific & Engineering Research, 9(2), 62-6.
23. Gupta, V. (2020). IoT enabled air pollution monitoring in smart cities. In Handbook of Wireless Sensor Networks: Issues and Challenges in Current Scenario's (pp. 569-591).
24. Gupta, K., & Rakesh, N. (2018). IoT based automobile air pollution monitoring system. In 2018 8th International Conference on Cloud Computing, Data Science & Engineering (Confluence) (pp. 14-15). IEEE.
25. Naik, U. U., Salgaokar, S. R., & Jambhale, S. (2023). IoT based air pollution monitoring system. International Journal of Scientific Research in Engineering Trends, 9, 835-8.
26. Srividya, P., & Devi, L. N. (2019). An IoT Based Vehicular Pollution Monitoring System for Automobile. In Proceedings of the 2019 2nd International Conference on Computational Intelligence and Intelligent Systems (pp. 173-176).
27. Francis, G. A., Dhinesh, M., Lijo, J. A., Hariprasad, P., & Balasubramanian, K. (2019). IoT based vehicle emission monitoring system. International Journal of Innovative Technology and Exploring Engineering (IJITEE), 8(5S), 410-2.
28. Kapadia, N. (2018). IoT and Cloud Based Vehicle Toll Collection System. i-Manager's Journal on Information Technology, 7(3), 30.
29. Devan, P. A., Hussin, F. A., Ibrahim, R., Bingi, K., & Nagarajapandian, M. (2019). IoT based vehicle emission monitoring and alerting system. In 2019 IEEE Student Conference on Research and Development (SCOReD) (pp. 161-165). IEEE.
30. Jiyal, S., Sheethlani, J., & Saini, R. K. (2022). Internet of things based air pollution prediction and monitoring system. Annales for Forestieres, 65(1), 7599-614.