A

B. TECH. PROJECT REPORT

On

REAL-TIME OXYGEN LEVEL DETECTION TO ENHANCE SAFETY

Submitted in partial fulfillment of the requirements for the award of the degree of

Bachelor of Technology in

Information Technology by

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Academic Year 2023 – 24

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CERTIFICATE

This is to certify that the B.TECH. Project Report Entitled

REAL-TIME OXYGEN LEVEL DETECTION TO ENHANCE SAFETY

Submitted by

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is a record of bonafide work carried out by him/her, under This guidance, in partial fulfillment of the requirement for the award of Degree of Bachelors of Technology (Information Technology) at Shri Vile Parle Kelavani Mandal's Institute of Technology, Dhule under the Dr. Babasaheb Ambedkar Technological University, Lonere, Maharashtra. This work is done during semester VIII of Academic year 2023-24.

Date:

Place: SVKM's IOT, Dhule

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DECLARATION

We declare that this written submission represents ideas in our own words and where other's ideas or words have been included, we have adequately cited and referenced the original sources. We also declare that we have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in our submission. We understand that any violation of the above will cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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ABSTRACT

The sewage system is vital to the lives of people in many developing nations, including India. Town employees are in charge of drainage system upkeep. The municipality must consider the health and safety of its employees when they enter the sewage system. Understanding the procedure and the tasks that the employees are performing is crucial. Controlling the amount of oxygen in the atmosphere is essential for maintaining ecological balance, supporting life, and guaranteeing the well-being of many ecosystems. “**Real-time Oxygen Level Detection to Enhanced Safety**" is a comprehensive real-time oxygen level detection solution that aims to enhance safety procedures in drainage in a variety of scenarios using the IOT. The system provides accurate and fast oxygen level monitoring by combining state-of-the-art sensor technology, data processing, and user-friendly interfaces. Because the person working in the drainage system can see where he has to start, the design is beneficial in assessing the oxygen levels. The aspect of the LCD shows to the worker that is oxygen levels. The LCD screen is used to identify the oxygen level in a manhole. One can determine the oxygen threshold limit value after the worker enters the manhole to assess his health. The signal is transmitted in the form of a help-seeking message on the user interface. The abstract examines how the Internet of Things-based oxygen sensors are connected and can process data. The user interface of the system will be designed with efficiency and simplicity in mind. Users can obtain historical trends, alert logs, and current oxygen level information using intuitive interfaces.

Keywords -: IoT, Drainage monitoring system, IOT, Monitoring smart city, accidents, Oxygen sensor, Internet of Things, ESP RainMaker.

CHAPTER 1

INTRODUCTION

In recent times, the significance of real-time monitoring systems for health parameters has gained paramount importance, especially in critical environments such as hospitals, industrial settings, and even personal spaces. Among these parameters, oxygen level detection stands out as a crucial metric for ensuring the well-being and safety of individuals.

1.1 Background

Our technology, which uses the Internet of Things, also called the IoT, for manhole detection and evaluating, is highly efficient in identifying the current state of manholes. A variety of sensors were used, including humidity, temperature, gas, and water flow sensors. The paper limitations of this project was fixed by placing a water flow rate sensor at the connection of nodes for tracking the speedat which sewage water flows. When a road blockage occurs, the flow of water varies, causing a variation in the water's drainage capacity. When this value is exceeded, the system will alert the managing station. We safeguard the employees' health who work for the municipality. We utilize several components in this system. Its input and output are extremely high. Working in drainage systems poses inherent risks to the safety and well-being of drainage workers, particularly in confined and oxygen-sensitive environments. The potential for oxygen depletion in these spaces necessitates proactive safety measures to mitigate the associated hazards. This research introduces a comprehensive solution: a real-time oxygen level detection system tailored to enhance the safety of drainage workers during their operations. Drainage systems, comprising underground tunnels, manholes, and confined spaces, present challenging work environments where fluctuations in oxygen levels can occur. The health and safety of drainage workers are paramount, and addressing the riskof oxygen depletion is crucial to preventing accidents and ensuring a secure workplace. The proposed real-time oxygen level detection system integrates cutting-edge sensor technologies, wireless communication modules, and intelligent algorithms. By strategically placing highly sensitive oxygen sensors in critical areas within drainage systems, the system continuously monitors oxygen concentrations. This real-time data is then processed using algorithms designed to account Wireless communication capabilities facilitate the instant transmission of data to a central monitoring unit, creating a command center where supervisors and safety personnel can actively oversee.

The user-friendly interface allows for real-time visualization of oxygen concentrations, and operators can establish customizable threshold values to trigger immediate alerts in case of deviations from safe levels. The significance of this system lies in its proactive approach to safety.

In the event of an oxygen level anomaly, the system activates a robust alert mechanism, including alarms, visual indicators, and automated safety protocols. This ensures that both workers and supervisors are promptly notified, enabling swift response to potential oxygen-related hazards.This paper delves into the architecture, sensor technologies, and algorithmic considerations of the proposed real-time oxygen level detection system for drainage workers. By addressing the specific challenges of their work environment, this system aims to not only enhance safety but also empower workers and supervisors with the tools needed to make informed decisions and prevent potential risks. The subsequent sections will detail the components, functionality, and potential applications of thi s innovative safety solution.

An Internet of Things tracking system and network suitable of detecting hazardous gases is aimed at helping drainage workers who endanger their own safety.Because of the harmful substances, this technique guarantees that sanitation workers face less dangers at work .Sanitation workers' deaths haverisen in the past few years. Inadequate waste disposal, along with exhaustion, leads drainage cleaning workers to die from diseases and injuries such as influenza and dysentery caused by sudden but prolonged contact to harmful gases. Septic pipelines are constructions that are frequently seen in industrialized urban and suburban areas, connecting residential and housing areas, and serving as a means of treating and moving waste products. Usually, as well as to send out a warning.The paper aims to provide timely monitoring and tracking of sewage or to keep an eye on the level of gas presence in the septic system.

The Drainage infrastructure and setup since the period of high economic growth in the country has to be being replaced, and work should be done upon and upgraded to be undertaken to maintain a safe andsecure water sewerage environment. This work needs to be undertaken efficiently but the drawbacks usually are a small number of workers and a tight budget. In light of this, work on sewage monitoring and drainage overflow control systems goes beyond day-to-day facility operation and maintenance to include maximizing the value of operational technology (OT) data obtained through these programs will luckily overcome the problems facing sewerage infrastructure and water supply, as well as contribute to the protection of the water environment. With the growing possibilities for sensing, tracking, and regulating with the Internet of Things (IoT) in recent years, more accurate information and sources, such as image data, are being considered. Image data was not traditionally used as sensing data, but with the advent of IOT, anything is possible. In the intricate tapestry of urban infrastructure, manholes stand as inconspicuous portals to a labyrinthine network of utilities.

Beneath the surface, where human eyes rarely wander, lies a world of confined spaces fraught with potential hazards. Among these hazards, the paramount concern is often the atmospheric composition within these subterranean chambers.

The introduction of oxygen level detection systems in manholes emerges as a crucial stride toward ensuring the safety of those tasked with venturing into these confined realms. The confined spaces of manholes present a unique set of challenges, demanding vigilance and technological solutions to mitigate risks effectively. Enclosed by earth and concrete, manholes often suffer from limited ventilation, leading to the potential for oxygen levels to plummet to perilous lows. Human survival relies on an oxygen-rich atmosphere, and any deviation from the norm poses severe threats to health and well-being. The introduction of advanced oxygen level detection systems serves as a sentinel, standing guard against the silent menace that may lurk below ground.

These detection systems are not merely technological marvels; they are the embodiment of a commitment to human safety in the face of occupational hazards. Designed with precision and calibrated for accuracy, these systems leverage cutting-edge sensor technologies to assess the oxygen levels within manholes. Operating on the principle that human life depends on a delicate balance of atmospheric gases, these detectors sound the alarm when the equilibrium is disrupted. In doing so, theyprovide a vital lifeline for those whose responsibilities lead them into the depths of these urban passageways.

The urgency of implementing such detection systems becomes apparent when considering the insidiousnature of oxygen depletion. Within confined spaces, the gradual displacement of oxygen by other gasesor substances can occur without warning. Without the ability to perceive this invisible threat, individuals entering manholes may find themselves in a perilous situation, breathing an air mixture that cannot sustain life. The consequences of such scenarios are dire, underscoring the critical.

Moreover, the deployment of oxygen level detection systems aligns with a broader societal commitment to occupational safety. As urban environments continue to expand and infrastructure maintenance becomes increasingly vital, the individuals tasked with these responsibilities deserve every safeguard available.

The integration of advanced technologies not only enhances efficiency but, more importantly, prioritizes the well-being of those laboring in conditions that demand heightened awareness.

In the following exploration, we delve into the mechanics and intricacies of these oxygen level detection systems. From the sensor technologies employed to the calibration processes ensuring accuracy, we unravel the layers of sophistication that underpin these critical safety measures.

Additionally, we examine the broader implications of their implementation, considering how they resonate with the evolving landscape of urban development and the ever-advancing frontier of technology.

As we navigate the subterranean landscape where man and machine converge, the importance of oxygen level detection in manholes becomes abundantly clear. Beyond the realm of technology, it symbolizes a commitment to safeguarding human life in the face of challenges lurking beneath our feet. In the chapters that follow, we embark on a journey through the depths of these confined spaces, unraveling the threads that weave safety, technology, and human resilience into the fabric of our urban existence.

One crucial component of the development of smart cities is the drainage management system. Manholes are the openings that allow scavengers to enter subterranean pipelines and clear obstructions from drainage pipes. The primary issues with manholes are the hazardously high quantity of poisonous drainage water, improper manhole lids, and overflowing drainage water. An IoT and sensor technology-based system can be used to overcome these issues.

The majority of nations lack an adequate sewage system, which leads to catastrophic accidents and damages. A few of the manholes lack the appropriate lid covering. When manhole covers or lids tilt, serious accidents occur and people are hurt. The scavengers that go via the manholes are devoid of any.

Manually identifying and keeping an eye on manhole issues is a laborious task that necessitates a person to be in front of every manhole at all times. Therefore, the primary goal of this project is to build a system that keeps track of the toxicity of the drainage water, the tilt of the manhole cover, and the level of sewage water beneath it.

The drainage water level is detected by ultrasonic sensors, and if the level is higher than the threshold, an alert message is sent to the relevant authority. The sensor's output is where the MCU node is linked. It sends a GSM alarm message to the person in charge, which is tracked by IoT, after comparing the specified threshold value

As part of our manhole detection and monitoring system project, we are able to feel the temperature and humidity inside the manhole, as well as the flow of water and harmful gasses. We alsohave the system send an IOT message to the municipal corporation. This technique also reduces the amount of labor required and creates situations that are simple to manage. The new system reduces those items, which makes the work safer and easier than the old one where the man had to enter the drainage system to clear the trash. There are substantial risks to employees' health and safety when working in drainage systems. One of the critical dangers they face is the potential lack of oxygen in confined spaces, leading to life-threatening situations. To address this concern, the implementation of real-time oxygen level detection systems becomes crucial to enhance the safety and well-being of drainage workers. In the realm of essential urban infrastructure maintenance, drainage workers play a pivotal yet perilous role in ensuring the functionality of drainage systems. The challenges they face are multifaceted, with confined spaces posing a significant threat to their safety, particularly concerning fluctuating oxygen levels.

The Real-time Oxygen Level Detection for Enhanced Safety presents a comprehensive solutionfor real-time oxygen level detection, aimed at enhancing safety measures in diverse scenarios. In this system integrates advanced sensor technology, data processing, and user-friendly interfaces to deliver accurate and instantaneous oxygen level measurements.

It explores the application of Internet of Things (IoT) technology for real-time oxygen level detection examines how Internet of Things-based oxygen sensors are connected and can process data. The user interface of the system will be designed with efficiency and simplicity in mind. Users can obtain alert logs, and current oxygen level information using intuitive interfaces.

1) Manhole detection and monitoring is an essential requirement for modern society, particularly smart city planning.

2) The concept of this project arises from the belief that missing or stolen manholes cause various road accidents and reduce the quality of the city.

3) Man had to go inside the drainage system to clean the garbage in the previous system, but the new system has made the work easier and safer by reducing those things.

4) Manhole detection and monitoring system based on IoT is a very useful system for all of us because it detects manhole conditions.

5) In our manhole detection and monitoring system project we have to detect the Oxygen Level in the manhole and it sends an IOT message or shown on display too.

6) In this system we have also reduced the work of manpower and easy to handle the situation.Confined spaces such as manholes pose inherent safety challenges due to factors like limited ventilation, fluctuating oxygen levels, and potential accumulation of hazardous gases. To address these risks, the implementation of a real-time monitoring system becomes imperative. This project aims to develop a robust solution for continuous monitoring of oxygen levels, temperature, and carbon dioxide concentrations within manholes, ensuring the safety of workers and preventing potential accidents. In urban infrastructure maintenance and utility services, manholes play a pivotal role by providing access to underground networks for inspection, repair, and maintenance. However, the confined and often hazardous nature of these spaces poses significant safety challenges for workers. Currently, ensuring the safety of personnel during manhole operations relies heavily on periodic checks and manual monitoring, which may not provide real-time insights into changing environmental conditions. Consequently, workers face risks associated with low oxygen levels, extreme temperatures, and the presence of toxic gases such as carbon dioxide.

Manholes, typically cylindrical structures embedded in roads or sidewalks, grant entry to underground utilities such as sewer systems, electrical conduits, and telecommunication cables. These criticalinfrastructures require regular maintenance to ensure uninterrupted service and public safety. Despite their importance, manholes present inherent hazards, including limited ventilation, confined spaces, and the potential accumulation of toxic gases due to decaying organic matter or industrial byproducts.

Maintenance activities within manholes involve tasks such as inspection, cleaning, and repair. These operations often require workers to enter the confined space, exposing them to various risks. Inadequate ventilation and the absence of real-time monitoring systems can lead to accidents andhealth hazards, including asphyxiation, heat stress, and exposure to toxic fumes.

Maintenance of manholes is essential to uphold the functionality of underground utility networks. However, conventional maintenance practices often involve manual entry by workers, exposing them to hazardous conditions. Moreover, inadequate lighting in manholes complicates inspection and maintenance tasks, increasing the risk of accidents. Additionally, the buildup of debris and sediment within manholes poses challenges for cleaning and maintenance operations, further exacerbating safetyconcerns.

One significant challenge faced in manhole operations is the lack of adequate lighting. Poor illumination impedes visibility, making it difficult for workers to assess their surroundings and detect potential hazards. Additionally, cleaning manholes presents another set of challenges, as accumulated debris, wastewater, and toxic substances pose health and safety risks to workers.

Current safety measures, such as periodic atmospheric testing and safety protocols, aim to mitigate risks associated with manhole entry. However, these measures rely on manual intervention and may not provide real-time insights into changing environmental conditions within the confined space. As a result, there is a pressing need for an advanced monitoring system capable of continuously assessing oxygen levels, temperature, and carbon dioxide concentrations in real-time to enhance safety for workers entering manholes.

Addressing these issues necessitates the development of a comprehensive monitoring system capableof real-time detection and alerting for oxygen levels, temperature fluctuations, and carbon dioxide concentrations within manholes. Such a system would significantly enhance worker safety by providing timely warnings and enabling proactive measures to mitigate risks associated with confined space entry. By integrating advanced sensors and communication technology, this project aims to revolutionize safety protocols in manhole maintenance operations, ensuring the well-being of workers and the uninterrupted functionality of critical urban infrastructure.

In this project, we propose the design and implementation of a real-time monitoring system specifically tailored to address the safety concerns associated with manhole entry. By integrating advanced sensors and wireless communication technology, we aim to enhance safety protocols, improve operational efficiency, and safeguard the health and safety of maintenance personnel working in confined spaces.

1.2 Motivation

The Motivation behind the project is to address crucial challenges in the Environmental sector. The presence of oxygen in the Manhole is essential for the survival of workers and for a number of reasons, measuring and detecting oxygen levels in the manhole is crucial. Drainage worker Health and Safety. It is crucial to accurately monitor and detect oxygen levels in order to ensure the health and safety of workers. Real-time oxygen level detection serves as a critical component in enhancing safety across various industries and applications. The motivation for implementing real-time oxygen level monitoring is rooted in the potential risks associated with fluctuations in oxygen level.

Here are several key motivations for using an oxygen level monitoring system in manholes:

1. **Oxygen Depletion Risk:** Confined spaces like manholes may have insufficient oxygen levels, leading to a potential risk of oxygen depletion. Inadequate oxygen levels can result in asphyxiation, which is a serious threat to the health and safety of individuals working in or entering such spaces.
2. **Regulatory Compliance:** Occupational safety regulations and standards often mandate the monitoring of confined spaces to ensure a safe working environment. Implementing an oxygen level monitoring system helps organizations comply with these regulations, reducing the risk of accidents and ensuring the well-being of workers.
3. **Early Warning System:** Oxygen level monitoring serves as an early warning system. If the oxygen concentration drops below a safe threshold, alarms are triggered, providing timely alerts to workers andsupervisors. This allows for quick response measures, such as evacuation or the use of respiratory protection equipment.
4. **Real-time Monitoring:** Continuous monitoring of oxygen levels in real-time provides a dynamic understanding of the conditions within the manhole. This enables proactive measures to be taken to address any changes in oxygen levels or the presence of hazardous gases promptly.
5. **Preventing Accidents and Fatalities:** The primary goal of implementing an oxygen level monitoring system is to prevent accidents and fatalities associated with confined spaces.
6. **Liability and Reputation Management:** Employers have a responsibility to ensure the safety of their workers. Implementing safety measures, such as oxygen level monitoring, not only reduces the risk of accidents but also helps manage liability and contributes to a positive reputation for the organization.

In summary, the motivation behind the oxygen level monitoring system in manholes is rooted in the need to safeguard the well-being of individuals working in confined spaces by detecting and mitigatingpotential hazards associated with oxygen deficiency and the presence of oxygen gas.

1.3 Aim and Objectives

Aim:

The primary aim of the project is to design, develop, and implement a sophisticated real-time oxygen level detection system tailored specifically for the safety and well-being of drainage workers. Theproject seeks to address the inherent risks associated with working in confined spaces within drainagesystems by introducing an innovative solution that provides continuous monitoring of oxygen levels aims to revolutionize safety practices within the drainage maintenance sector, setting a new standardfor real-time monitoring and responsiveness. Ultimately, the project seeks to save lives, prevent accidents, and create a safer and more secure working environment for drainage workers.

Objectives:

The primary objective of this research is to develop and implement a real-time oxygen level detection system specifically tailored to enhance the safety of drainage workers during their operations in confined and potentially hazardous environments. The system aims to address the unique challenges posed by drainage workspaces and provide an effective solution for preventing and mitigating the risks associated with oxygen deficiencies. The key objectives of this study are as follows:

7) Safety Enhancement for Drainage Workers.
8) Adaptation to Drainage Work Environments.
9) Real-time Monitoring and Early Warning.

When developing a project for an oxygen level monitoring system in manholes to enhance safety, it's essential to establish clear objectives to guide the project team and ensure its success.

Here are some key objectives for such a project:

1. Ensure Worker Safety:

- Objective: Implement a reliable oxygen level monitoring system to safeguard the well-being of workers entering manholes.
- Key Results: Achieve a consistent and accurate monitoring of oxygen levels to prevent incidents of oxygen depletion.

2. Early Detection of Oxygen Depletion: - Objective: Develop a system that provides early warnings in case of a decrease in oxygen levels within the manhole.

Key Results: Set up alarms and alerts triggered when oxygen levels fall below predetermined safe thresholds, allowing for prompt corrective actions.

3. Real-time Monitoring and Reporting:

- Objective: Establish a real-time monitoring system with continuous data recording and reporting capabilities.
- Key Results: Enable instant access to oxygen level data and associated parameters, facilitating quick decision-making and response.

4. Integration with Safety Protocols:

- Objective: Integrate the monitoring system with safety protocols and procedures for confined space entry.
- Key Results: Ensure that the system aligns with existing safety guidelines, enhancing overall safety practices during manhole-related activities.

5. Compliance with Standards and Regulations:

- Objective: Ensure that the oxygen level monitoring system complies with relevant occupational safety standards and regulations.
- Key Results: Regularly update the system to meet any changes in safety standards and regulations, demonstrating commitment to legal compliance.

6. User-Friendly Interface:

- Objective: Develop an intuitive and user-friendly interface for the monitoring system.
- Key Results: Simplify user interactions, facilitate easy system operation, and provide clear 3visualizations of oxygen levels and potential hazards.

7. Remote Monitoring Capability:

- Objective: Enable remote monitoring of oxygen levels to reduce the need for physical presence in hazardous environments.
- Key Results: Implement a secure and reliable remote access system for monitoring, allowing personnel to observe conditions from a safe location.

8. Training and Awareness Programs:

- Objective: Conduct training programs to educate personnel about the importance of the monitoring system and how to respond to alerts.
- Key Results: Ensure that workers are well-informed and capable of responding appropriately to monitoring system alerts and alarms.

9. Continuous Improvement and Maintenance:

- Objective: Establish a routine maintenance schedule and a process for continuous improvement of the monitoring system.
- Key Results: Regularly update and maintain the system to address evolving safety needs and technological advancements.

By defining clear objectives, the project team can focus on developing and implementing an effective oxygen level monitoring system that enhances safety in manholes and aligns with organizational and regulatory requirements.

1.4 Scope

The scope of this research encompasses the development, implementation, and evaluation of a real-time oxygen level detection system specifically designed to enhance the safety of drainage workers in their operational environments. The study will focus on addressing the unique challenges posed by drainage workspaces and aims to provide a comprehensive solution for ensuring the well-being of workers. The study will focus on the following key aspect **:**

1. **System Design and Development:** Develop a wearable device equipped with advanced sensors capable of accurately measuring and monitoring oxygen levels in real-time.Design the device to be ergonomic, lightweight, and resistant to the harsh conditions encountered in drainage systems.

2. **Alert System Implementation:** Implement an intelligent alert system that triggers notifications when the oxygen levels deviate from the safe range.Ensure the alerts are communicated to both the individual worker wearing the device and a centralized control station for immediate response.

3. **Centralized Monitoring System:** Establish a centralized monitoring system capable of collecting, processing, and analyzing real-time data from multiple wearable devices. Implement a user-friendly interface for supervisors to monitor the oxygen levels of multiple workers simultaneously.

4. Power Management: Implement efficient power management solutions for both sensors and the central monitoring system.Ensure the system has backup power options to prevent failures during power outages**.**

5. Hardware Development:

- Designing and prototyping of the oxygen level detection sensor.
- Selecting appropriate hardware components for reliable and accurate readings.
- Integrating the sensor with existing systems or devices for seamless data transmission.

6. Software Development:

- Developing algorithms for real-time monitoring and analysis of oxygen levels.
- Creating a user-friendly interface for data visualization and system control.
- Implementing alert mechanisms for abnormal oxygen level readings.

7. Integration:

- Integrating the hardware and software components to form a cohesive system.
- Testing interoperability and compatibility between different system modules.
- Ensuring seamless data flow and communication between sensors, processors, and user interfaces.

8. Deployment and Testing:

- Deploying the system in relevant environments (e.g., industrial settings, confined spaces, medical facilities).
- Conducting rigorous testing to validate the accuracy and reliability of the system.
- Collecting feedback from users to refine and optimize system performance.

9. Safety Enhancement:

- Implementing safety protocols and procedures based on detected oxygen levels.
- Establishing thresholds for oxygen levels and defining corresponding actions or alerts.
- Providing recommendations for preventive measures to mitigate risks associated with oxygen level fluctuations.

1.5 Report Organization:

The thesis is meticulously structured into eight chapters, with each chapter serving as a distinct entity enriched with comprehensive theory to provide a thorough understanding of its content. Starting with the introduction, which sets the stage for the entire thesis, it lays out the groundwork by presenting the overarching theme and objectives of the research. This initial chapter acts as a roadmap, guiding the reader through the subsequent chapters while outlining the significance and relevance ofthe study in the broader context of the field.

Chapter 2 discuss the section of literature survey provides a critical analysis of the literature, discussing the strengths and weaknesses of existing research, any contradictions or gaps you identified, and the overall quality and relevance of the literature to your project. It discusses the implications of the literature findings for the project and any recommendations for future research or practice based on the review. Summarizes the main findings from each group of literature, highlighting key insights and trends.

Chapter 3 talks about the Problem Statement Description of the Problem Clear articulation of the specific challenges and issues addressed by the project. Importance of Addressing the Problem Explanation of the potential risks and consequences associated with inadequate oxygen level monitoring.

Stakeholders and Their Concerns: Identification of the individuals or groups affected by the problem and their interests in finding a solution. Constraints and Limitations: Discussion on any constraints or limitations that need to be consideredduring the development of the proposed system.

Chapter 4 discuss the overview of the system architecture, including hardware, software, and network components. It also illustrates the data flow within the proposed system, showing how information will be processed and exchanged. It includes information about the new system you are suggesting to implement. This section typically outlines the changes, improvements, or enhancements that the proposed system will bring compared to the current system.

Chapter 5 talks about the High-level overview of the architecture and functionality of the proposed system. This section encompasses narrative and graphical documentation of the system design, such as use case diagrams, object diagram , state diagrams, and sequence diagrams. It also covers aspects like system architecture, process design, output design, input design, database design, and system flowchart. System design is a crucial phase that transitions from a user-oriented document to one oriented towards programmers or database personnel. It involves structuring the design into parts like output design, input design, database design, and system flowchart.

Chapter 6 discuss the feasibility study is a comprehensive evaluation of a proposed project, product, or business idea to determine if it is viable and worth pursuing. The main purpose of this chapter feasibility study is to assess the practicality of the idea from various perspectives, including Technological Feasibility for evaluating the technical requirements, capabilities, and costs needed to implement the project. Operational Feasibility for evaluating the organization's ability to complete the project in terms of staffing, structure, and legal requirements.

Chapter 7 descibes the Experimental Results and Methodology: Explanation of the experimental setup and procedures followed during testing. Data Collection: Presentation of the data collected from real-world experiments or simulations. Analysis and Interpretation: Examination of the results and their implications for the effectiveness ofthe proposed system.

Chapter 8 discuss the Summary of Findings: Recap of the key findings and outcomes of the project. Contributions: Discussion on the contributions of the project to the field of real-time oxygen level detection and safety. Future Work: Suggestions for future research or improvements to the proposed system. Final Remarks: Closing thoughts on the significance of the project and its potential impact on enhancing safety through real-time oxygen level monitoring.

CHAPTER 2

LITERATURE SURVEY

2.1 Survey Existing Systems

In 2021, [1] the researchers G. Ramesh, D. A. Kumar, P. M. Khan, G. V. K.Teja and B.Singh worked on a new device called an Electronic Sniffing Mask that purports to improve the safetyof sewage workers by constantly detecting unsafe fumes in real-time.Currently available systems feature sensors that can detect different poisonous gasses found in sewage surroundings.If dangerous levels are identified, the mask sends alerts to warn employees so that they can respond appropriately.Alternatively, the mask can be connected to central monitoring system to facilitate remote supervisions of employee's safety standards.To guarantee healthy lives for sewerage staffs during their operations (Ramesh et al., 2021). In 2022, [2] The authors R.Dronavalli, K.Seelam, P.Maganti, J.Gowineni, and S.D.Challamalla sought after Improved Safety of Sewer Workers with Automatic Manhole Observant Using Internet of Things(IoT) Based System. The system incorporates sensors which determine parameters such as gas levels, temperature, humidity and toxic substances presence within it. IoT-based technology is used to monitor and detect potentially hazardous situations in manholes; this is possible through its combination with sensor networks for example measuring data such as CO2 levels and temperature . In 2023, [3] K. Ravi Kumar, G. Jagan Mohan, P. Devi Vara Prasad, G. Rohin Kumar and K Vijaya Lakshmi investigated this with The Smart Manhole Monitoring System as an advanced method aimed at improving manhole inspection and maintenance safety and effectiveness. This system includes a combination of different sensors and IoT technology that monitors diverse information like gases levels, temperature, moistures and water level in the sewers continuously. A real-time data collection and analysis system easily detects potential hazards such as poisonous gases, flooding, or any other abnormal conditions. Once recognized, the system consequently notifies relevant personnel making them take prompt actions to avert accidents or damages. In addition the Smart Manhole Monitoring System through data analytics can offer valuable insights that help optimize maintenance schedules, track trends and enhance infrastructural management practices on an overall basis. It is this systems aspiration to minimize workers' risks, enhance operational efficiency and make manholes last for long in ensuring that they are safer places to work in and urban environments that are moresustainable.

In 2023 ,[4]D. Mishra, I. Dushettiwar, P. Rane & S. Daware worked on Manhole Monitoring And Detection Using IoT. The objective of this research paper was to present a complete system which can improve safety and maintenance efficiency of manholes. This IoT technology based system is used for monitoring different parameters like gas levels within manholes; temperature and humidity; water levels etc. Sensors integrated with communication modules collect real-time information from the manholes which then gets sent directly as monitored signals to a main control room.In 2022,[5] J.Zhang and X.Zeng authored The research paper "Design of Intelligent Manhole Cover Monitoring System Based on Narrow Band Internet of Things" that looks at a sophisticated design for monitoring manholes with narrowband Internet-of-Things (NB-IoT). For example, in order to find out if they are open or closed or interfered with sensors using NB-IoT technology built into the covers collect real- time information about them while transmitting it wirelessly to a central monitoring platform which helps remote authorities monitor manhole cover conditions. It offers a range of benefits such as improved surveillance efficiency through easy detection of unauthorized entry or tampering, proactive maintenance scheduling leading to reduced maintenance costs among others by integrating NB-IoT technology. In conclusion, this paper provides a strong solution for improving urban infrastructure management and security mainly in preventing damage to the sewer system caused by stolenmanhole covers. In 2022 ,[6]Y. Liang, L. Chen and B. Xu, worked on Design of Intelligent Management System for Manhole Cover presents a comprehensive approach to managing manhole covers efficiently and intelligently. The system integrates advanced technologies to monitor the status and condition of manhole cover.

In 2021, [7]Y. Xie, H. Wang, J. Liu, R. Zhang, and Y. Guo conducted research on a working monitoring system for manhole wells. Based on Internet of Things technology, provide a full description of a monitoring system meant to oversee the functionality and condition of manhole wells. The system uses the Internet of Things (IoT) to collect real-time data from sensors put in manhole wells. These sensors can monitor a variety of characteristics in manhole wells, including water level, gas concentrations, temperature, and humidity. The collected data is wirelessly transferred to a central monitoring station or cloud-based platform and analyzed in real time. Using data analytics techniques, the system can detect anomalies like flooding orin the presence of hazardous gasses, and instantly notify maintenance workers. The study report will most likely go into detail on the monitoring system's design, implementation, and performance evaluation, covering hardware components, communication protocols, data processing algorithms, and user interface.

Management methods by presenting an IoT-based monitoring system specifically designed for manholewells, with the goal of improving operating efficiency, preventing accidents, and ensuring worker safety.

In this research [8] author collaborated in 2022 to develop manhole cover detection and continuous monitoring of hazardous gases utilizing WSN and IoT technology. They offer a complete approach for improving safety and efficiency in urban infrastructure management, with a focus on manhole covers and hazardous gas monitoring. To achieve its objectives, the system makes use of Wireless Sensor Networks (WSN) and the Internet of Things (IoT). It employs sensors on manhole covers to determine their condition (open or closed) and monitors the surrounding environment for harmful gases such as methane, hydrogen sulfide, and carbon monoxide. The data obtained by the sensors is wirelessly transferred to a central control unit or cloud-based platform via IoT connectivity.

In 2023, [9] author collaborated on "IoT Based System for Manhole Monitoring and Management," which describes a comprehensive solution to the issues connected with manhole monitoring and management in urban areas. This system uses Internet of Things (IoT) technology to track the state and condition of manholes in real time. It includes a variety of sensors, including proximity sensors, temperature sensors, and gas sensors, that are put within or around manholes to collect data on factors such as cover status, temperature, and gas levels. The collected datais wirelessly transported to a central management platform, where it is processed, analyzed, and presented to stakeholders. This software allows authorities to remotely monitor the condition of manholes and receive alerts in case of anomalies (such gas leaks or open covers), and effectively oversee maintenance programs. In addition to lowering the possibility of accidents and infrastructure damage, this technology also improves worker and public safety and increases operational efficiency through proactive maintenance techniques.

[10] Researchers Y. Nandini, K. V. Lakshmi, T. I. S. Srujan, M. Yasswi, and K. S. Jagadish worked on the research paper "Design of Real-Time Automatic Drainage Cleaning and Monitoring System using IoT" in 2023. The paper describes the development of an inventive system that uses Internet of Things (IoT) technology to improve the efficacy and efficiency of drainage cleaning processes. This technology allows for the real-time monitoring of drainage systems by integrating sensors and IoT devices. These sensors gather information on a number of variables, including water levels, flow rates, and obstructions in the drainage system. The technology uses this information to automatically identify possible obstructions or problems in the drainage system and starts

Additionally, it has the ability to send notifications and alerts to authorities or maintenance staff when anomalies are found, making timely action possible. The design and implementation aspects of the system, such as sensor selection, communication protocols, data processing algorithms, and userinterface, are probably covered in the study paper.

The Smart Drainage and Health Monitoring System of Manual Scavenger using Internet of Things (IoT) was developed in 2021 by S. P. K. Ramadhin, S. Anand, R. Aishwarya, and Y. R.[11] It offers a novel way to enhance the security and welfare of manual scavengers operating in drainage systems through the use of IoT technology. This system combines sensors and Internet of Things devices to track the health metrics of manual scavengers as well as the drainage environment in real time. By gathering information on variables like temperature, humidity, flow rates, and gas concentrations, sensors installed in the drainage system enable the early identification of potentially dangerous situations. Furthermore, manual scavengers are outfitted with wearable health monitoring devices to check vital indications like heart rate, body temperature, and oxygen saturation levels. This makes ongoing keeping an eye on their health while working in potentially dangerous conditions. The gathered data is wirelessly transferred to a central monitoring platform for analysis. In the event of abnormal situations, automated notifications can be created, enabling prompt response to guarantee the security of manual scavengers. Of monitoring systems powered by IoT. This method has the ability to greatly lower the dangers involved with manual scavenging and enhance the general health and safety of field personnel.

[12]The Smart System for Hazardous Gases Detection and Alert System utilizing Internet of Things, developed in 2021 by R. S. Ganesh, M. Mahaboob, author describes a comprehensive system to improve safety in areas where hazardous gases may be present. The system uses Internet of Things (IoT) technology to continuously monitor and identify dangerous gas levels. This system has sensors that can identify a number of dangerous gases, including carbon monoxide, hydrogen sulfide, and methane. These sensors are positioned carefully in areas like mines, restricted spaces, and industrial sites where there is a high risk of gas exposureor leaks. Wireless transmission of the sensor data to a central monitoring platform or control room through Internet of Things protocols. The platform continuously checks for abnormal gas levels by processing and analyzing the data in real-time. The device automatically warns necessary workers or authorities when dangerous gas levels surpass predefined parameters. This makes it possible to take preventative action and swift action to safeguard worker and environmental safety. The design, implementation, and

performance evaluation of the smart gas detection and warning system, including sensor selection, communication protocols, data processing algorithms, and user interface, are probably covered in full in this research article.

The Iot Based Drainage and Waste Management Monitoring and Alert System for Smart City, developed in 2021 ,[13] by M. Aarthi and A. Bhuvaneshwaran, offers a comprehensive solution to the problems associated with managing urban infrastructure in smart cities. The suggested solution makes use of Internet of Things (IoT) technologies to provide real-time monitoring and control of waste management and drainage systems. It combines a number of sensors that are dispersed across the infrastructure of the city to gather information on variables including water levels, flow rates, garbage bin fill levels, and ambient temperatures. IoT connection methods are used to wirelessly transfer the sensor data to a centralized monitoring platform. In order to find abnormalities and possible problems with the waste management and drainage systems, the platform evaluates the data and uses analytics algorithms. The system's alert function, which instantly alerts pertinent parties, including city officials or maintenance staff, when anomalies or urgent circumstances are discovered, is one of its most important aspects. This makes it possible to respond quickly and take action to stop or lessen possible issues.

In 2018, [14] Dhanalakshmi.G, Akhil.S, Francisca Little Flower.M, and Haribalambika.R developed an Explosion Detection and Drainage Monitoring System using Automation. The system addresses safety and efficiency concerns in industrial contexts by integrating automation technology. This paper's proposed system combines explosion detection capabilities with drainage monitoring functionality to provide a comprehensive approach to safety and maintenance. The system will most likely include a variety of sensors capable of detecting changes in gas levels, temperature, and pressure, all of which are common signs of possible explosions. These sensors continuously monitor the surroundings and provide information to a central control system. In addition to explosion detection, the system also has drainage monitoring capabilities. Sensors are put throughout the drainage network, monitoring characteristics such as flow. Rates, liquid levels, and possible obstructions. Any anomalies discovered in the drainage system are promptly reported to the central control system. The central control system processes data from both explosion detection sensors and drainage monitoring sensors in real time. It analyzes the data and initiates appropriate responses, such as triggering safety protocols in the event of an explosion or notifying maintenance people about drainage concerns.

[15] This research article appears to focus on an IoT-based system aimed to improve the safety of sewage workers by automatically monitoring manholes. This system will most likely use sensors and IoT technology to monitor manhole conditions and deliver real-time data to maintain worker safety. It is a critical field of research since it addresses the safety concerns of those who work in sewage systems. [16] The purpose of this research paper is to investigate the development of a smart city application using Raspberry Pi and IoT technologies to monitor many elements of urban life. This would most likely include deploying sensors and devices connected to Raspberry Pi boards to collect data on parameters such as air quality, traffic flow, noise levels, waste management, etc energy consumption. The collected data is then processed and analyzed to provide insights that can be used to optimize city services and improve the quality of life for residents. By leveraging IoT and Raspberry Pi, the goal is to create a cost-effective and scalable solution for building smarter and more sustainable cities.

The research [17] article focuses on creating an IoT-based smart drain monitoring system with alarm messaging capabilities. This method most likely entails installing sensors in drains to monitor characteristics such as water level, flow rate, and quality. The sensors send data to a central control unit or cloud platform, which processes and analyzes it in real time. If abnormal conditions are recognized, such as a rise in water level signaling potential flooding, the system sends alert messages to the appropriate authorities or stakeholders via SMS or other communication channels. The purpose is to give early warnings and prompt response to reduce the hazards associated with drainage issues including urban flooding and environmental pollution.

This research [18] article focuses on creating an edge computing-based intelligent manhole cover management system for smart cities. This system is expected to include sensors and computer equipment placed directly on or near manhole covers to monitor characteristics such as temperature, pressure, and movement. The edge computing architecture allows for real-time processing and analysis of data acquired directly from these sensors, decreasing latency and bandwidth needs. The system may use machine learning algorithms to detect abnormalities or patterns that indicate possible problems, such as illicit access, obstructions, or structural deficiencies in the manhole covers. When anomalies are found, the system can generate alerts or messages to relevant authorities or maintenance workers, allowing for prompt response and intervention.

This research [19] study focuses on creating a smart drainage system with Zigbee and IoT technology. This system most likely entails installing Zigbee-enabled sensors and devices in drainage.

The Zigbee protocol allows for low-power, short-range wireless communication between these sensors and a central control unit or gateway. The sensors gather data on drainage conditions and send it to the control unit in real time. Thecontrol unit, which may be connected to the internet, collects and analyzes the data collected from the sensors. It can detect irregularities or prospective problems, such as blockage, flooding, or pollution occurrences. When anomalies are found, the system can provide warnings or notifications to relevant stakeholders, such as city officials.or maintenance people, using IoT platforms or mobile apps.The purpose of this study is to create an efficient and dependable smart drainage system that may improve the management and maintenance of urban drainage infrastructure, thereby contributing to the resilience and sustainability of smart cities.

In this research [20]article focuses on developing a supervision and management system for ownerlessmanhole covers using RFID technology. To uniquely identify and track manhole covers, this system will most likely include inserting RFID tags or chips.RFID tags connect wirelessly with RFID readers positioned in key locations, such as city roadways or sewer networks. These readers can detect the existence and location of manhole covers in real time.[21] This research article focuses on creating an IoT-based sewage monitoring system. This system most likely entails installing sensors and devices in sewage infrastructure to monitor characteristics such as flow rate, volume, temperature, pH levels, and contaminant concentrations. The sensors gather real-time data on sewage conditions and wirelessly sendit to a central control unit or cloud platform.

This research [22] article focuses on creating an automated Internet of Things (IoT) system for monitoring underground drainage and manholes in major cities. This system most likely combines multiple IoT devices and sensors installed in underground drainage networks and manholes to monitor critical factors such as water level, flow rate, temperature, and structural integrity. The IoT devices capture real-time data from the subsurface infrastructure and send it wirelessly to a central control unit or a cloud platform. This information is then processed and analyzed to identify anomalies such as clogs, leaks, or structural damage, which could result in flooding, pollution, or safety risks.

[23] This research article focuses on the usage of Long Short-Term Memory (LSTM) networks for battery management in manhole subterranean systems. This entails placing sensors and gadgets with batteries in manholes to monitor temperature, humidity, gas levels, and structural integrity. The LSTM network is used to anticipate the battery's state of charge (SoC) and state of health (SoH) using historical sensor data. By examining data patterns and trends, the LSTM model can

battery's performance and remaining capacity over time. The anticipated SoC and SoH values are utilized to optimize battery management tactics like charging times, energy harvesting, and power allocation.

This research [24] article focuses on creating a web-based manhole overflow prediction system that employs ultrasonic level sensors and an expert system. This technology is anticipated to use ultrasonic level sensors in manholes to continuously monitor water levels. The data collected by these sensors is transferred to a central server or cloud-based platform that may be accessed via the internet. The platform includes an expert system that analyzes sensor data and predicts the likelihood of manhole overflow incidents, which could be based on machine learning algorithms or rule-based reasoning. To create accurate predictions, the expert system takes into account a variety of parameters, including historical data, weather conditions, and drainage network characteristics. When the system detects a high risk of overflow, it can send alerts or notifications to appropriate stakeholders, such as municipal authorities.

This research [25]article focuses on developing a system for monitoring and managing missing manhole covers, including an alarm system for prompt detection and response. This technique most likely entails placing sensors or detectors on manhole covers around urban areas to detect their presence. When a manhole cover is missing or shifted, the sensors send an alarm, signaling a potential safety concern or infrastructure problem. This warning signal is routed to a central monitoring and management system, where it is processed and interpreted. The technology can automatically send warnings or notifications to relevant authorities, such as municipal agencies or maintenance teams, with real-time information regarding the location and status of the missing manhole cover.

[26] This research article focuses on creating an IoT-based manhole detection and monitoring system. This system is anticipated to entail the deployment of IoT-enabled sensors and devices in and around manholes to detect their presence and monitor various characteristics. Sensors may include proximity sensors, cameras, or pressure sensors to detect the presence of manhole covers and monitor parameters such as temperature, humidity, gas levels, and water levels within the manhole. This research [27] study focuses on creating a Manhole Detection and Monitoring System with IoT Technology. This system uses sensors and devices with IoT capabilities to detect manholes and monitor various characteristics related with them. Sensors such as proximity sensors, cameras, or pressure sensors are strategically placed near manholes as part of deployment. These sensors detect the opening and closing of manhole covers while also monitoring temperature, humidity, gas

manhole. The fundamental goal of this project is to create an effective and dependable IoT-based system for identifying and monitoring manholes. This method attempts to improve urban infrastructure management and maintenance while also increasing urban safety and resilience.

This research [28] study focuses on creating a Smart Manhole Monitoring and Detection System with inexpensive single-board computers (SBCs). This technology embeds SBCs like Raspberry Pi or Arduino into manhole covers or neighboring infrastructure, resulting in a compact and efficient monitoring solution. The system uses a variety of sensors and detectors to monitor characteristics such as water levels, gas concentrations, temperature, and structural integrity inside the manhole. These sensors are coupled to SBCs, which serve as central processing units. The research intends to create a cost-effective and scalable Smart Manhole Monitoring and Detection System employing inexpensive single-board computers, which will improve urban infrastructure management and maintenance while also improving safety and resilience.

This research [29] article focuses on creating a system for detecting and removing obstructions in manhole pipes using IoT technology. This system uses sensors, actuators, and IoT-enabled devices to monitor the health of manhole pipes and respond when obstructions are discovered. Ultrasonic sensors or pressure sensors are installed inside manhole pipes to continuously monitor the flow of sewage or wastewater. These sensors detect variations in flow patterns or pressure, which can indicate the presence of an obstruction. The study's goal is to create an effective and dependable system for detecting and eliminating blockages in manhole pipes using IoT technology, which will improve urban sewage system management and maintenance while also increasing public health and safety. [30] This research study focuses on establishing an IoT-based smart drainage worker safety system to improve the safety of workers participating in drainage maintenance and operations. This system uses a variety of IoT technologies to monitor and control any dangers and risks related with drainage construction.

2.2 Limitations of Existing Systems

1. Sensor Accuracy: The accuracy and reliability of oxygen sensors may vary, leading to potential inaccuracies in readings. Calibrating and maintaining these sensors regularly is essential to ensure precise measurements.
2. Environmental Factors: External factors such as temperature, humidity, and air pressure can influence oxygen levels and may affect the accuracy of readings. Accounting for these variables and implementing compensation algorithms may be necessary to improve reliability.

3. Response Time: The response time of the oxygen detection system may not be instantaneous, leading to delays in detecting changes in oxygen levels. Minimizing response time is crucial, especially in critical safety applications where rapid detection is essential.

4. Power Consumption: Continuous monitoring of oxygen levels in real-time requires a constant powersupply, which can be a limitation in remote or battery-operated systems. Optimizing power consumption to prolong battery life or ensuring uninterrupted power sources is necessary for sustained operation.

5. Maintenance Requirements: Regular maintenance, including sensor calibration, cleaning, and system checks, is essential to ensure the accuracy and reliability of the detection system. Failure to perform maintenance tasks can lead to degraded performance or sensor malfunction.

6. Data Interpretation: Interpreting the data obtained from oxygen level detection requires expertise to differentiate between normal fluctuations and potentially hazardous situations. Providing clear indicators or alarms for abnormal oxygen levels is crucial to assist users in taking appropriate actions.

7. Integration Challenges: Integrating the oxygen detection system with existing safety infrastructure or control systems may pose compatibility challenges. Ensuring seamless integration and interoperability with other systems is essential for effective implementation.

8. Cost: High-quality oxygen sensors and real-time monitoring systems can be expensive, especially for large-scale deployments. Balancing the cost-effectiveness of the solution with the need for accurateand reliable oxygen level detection is a consideration.

9. Limited Coverage: Depending on the deployment scenario, there may be limitations in coverage areas for oxygen level detection. Extending coverage to all relevant areas, especially in complex or large environments, may require additional sensors and infrastructure.

10. Safety Regulations: Compliance with safety regulations and standards governing oxygen monitoring systems is critical. Failure to meet regulatory requirements can lead to legal implications and compromise safety standards.

Addressing these limitations through careful design, implementation, and ongoing maintenance is essential to ensure the effectiveness and reliability of real-time oxygen level detection systems for enhancing safety.

CHAPTER 3

PROBLEM STATEMENT

The objective of this project aim to solve the challenges Furthermore comprehensive solution for real-time oxygen level detection, aimed at enhancing safety measures in the scenario of manhole.This next proposed system integrates recent sensor technologies via user-friendly interfaces to deliver precise and quick oxygen level monitoring. Drainage workers often operate in confined and poorly ventilated spaces, where oxygen levels can fluctuate rapidly due to various factors such as decomposing organic matter, chemicals, and lack of proper air circulation. Traditional safety measures, though effective to some extent, may not provide real-time data on the atmospheric conditions, leading to potential hazards and accidents. Thus, there is a pressing need for an advanced system that continuously monitors and communicates the oxygen levels in real-time.

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- The motivation for this project arises from the idea that damaged or destroyed sewers cause a number of crashes and degrade the quality of the city.
- The previous approach requires a person to go into a drainage system to clear all the garbage, but the latest technology has simplified the work simpler and more secure with reducing such materials
- Man had to go inside the drainage system to clean the garbage in the previous system, but the new system has made the work easier and safer by reducing those things.
- Manhole detection and monitoring system based on IoT is a very useful system for all of us because it detects manhole conditions.
- Our manhole detecting and tracking the system project enables us to measure the level of oxygen inside the manhole and communicate an IOT signal that is displayed on a mobile device.
- In this We have also lowered the amount of people required for this system, making it easier .

CHAPTER 4

PROPOSED SYSTEM

4.1 System Architecture with Stages of Development:

- Nowadays, Accidents causing broken and damaged covers for manholes are quite common. Manholes have not been properly verified in poor countries. These incidents may result in serious damage as well as death.
- Hence, Here, we provide a method that resolves this issue as well. We implemented several kinds of sensors that monitor the cover on manholes in real time, thereby providing us to prevent such incidents.
- This project involves a gas detection covers to track the gas discharged from the drainage systems so that harmful effects is easily observed, the temperature inside is monitored as well ifa check for a change in the temperature as the property of the manhole modifies with the temperature which could need to crack formation, and a tilt sensor has been added to show whether the manhole can tilt.
- Additionally, a float monitor is used to notify us when the water level exceeds over a particular level; in case of a notification because of any of the parameters, we send an SMS to an approved number as well as on the Internet of Things website.
- The webpage displays all parameter continuously.

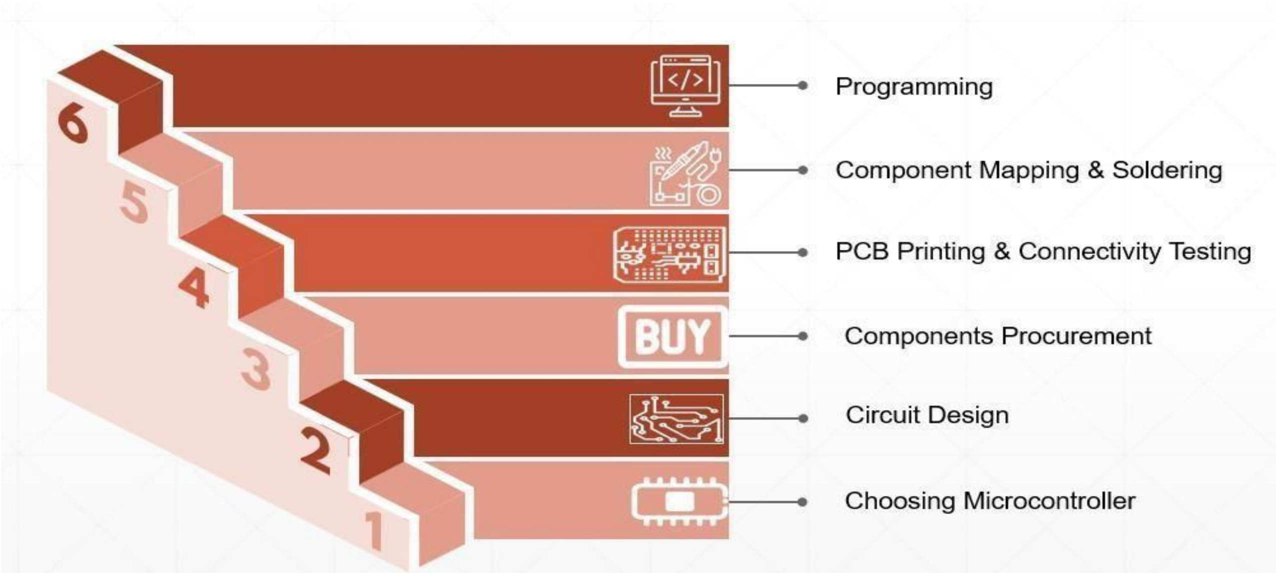

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Fig 4.1 Stages of Development

4.1.1 Proposed Methodology:

The proposed architecture for the real-time oxygen level detection system for drainage workers aims to provide a proactive safety solution that not only detects and alerts but also empowers drainage workers and their supervisors to create a safer and more secure working environment. Through in Fig. 4.1.1 its comprehensive design and functionality, the system is poised to significantly enhance the safety of drainage operations. In our proposed system, we are using the Node MCU, Relay, and power supply. This control project assists in preserving the city's underground drainage environment & will minimize the amount of work needed by government workers.

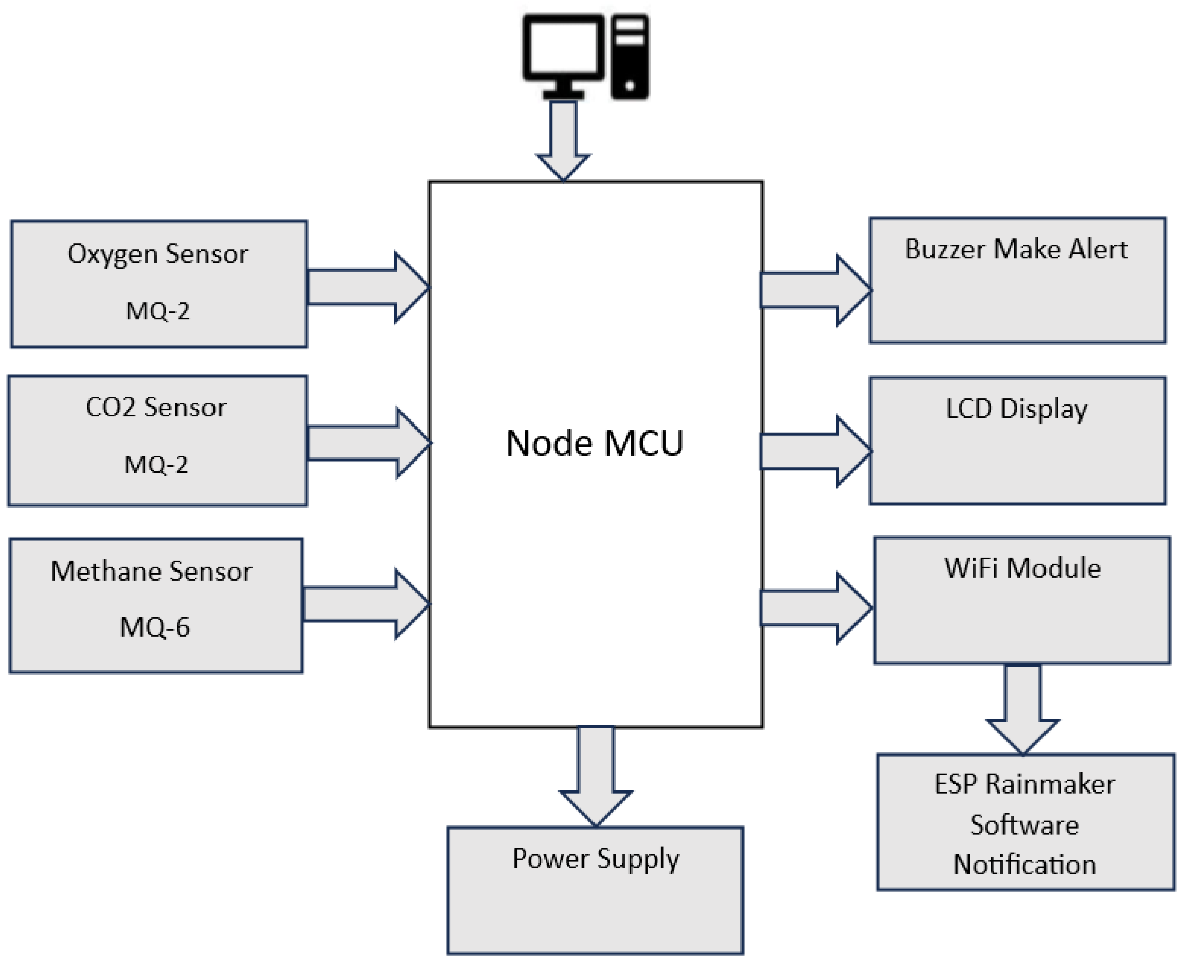

Fig 4.1.1 Architecture Diagram

In order to make the device smart, sensing elements (oxygen sensor to measure oxygen level) are included. Furthermore, the signal and position of the manhole are sent to the concerned via Global system for mobile communication and Global Positioning System, allowing to quickly identify which sewer has the issue to take measures. Additionally, using IoT gives the real time outputs of sensing elements in the sewer. On the LCD, there will also be a message. The sensors data are monitored through the IOT Cloud webpage. The updates are frequently happening at the time of sensors data variation The location of the sewage we can monitor through the IOT. At the same time we can get status of the sewage and health monitoring of that person via IOT We can give alert to the people if any problem via buzzer module which is connected with the Arduino. And the next term is to get the safety precautions to action on manhole directly.

4.1.2 Flow chart of the proposed system:

A methodical procedure for connecting a device to a network is described in the document. First, sensors for CO2 and oxygen are incorporated. These are made to convert analog data to digital format and compare it with pre-established limits. In Fig. 4.1.2 A buzzer signal is activated and data is transmitted to a web server and the user's mobile device to provide a warning if the sensor value falls below the threshold. The mention of a methane sensor at the end of the procedure may indicate that there are still measures to be taken in the system as a whole.

The article essentially outlines the process for connecting a device to a network, especially when sensordata and user notifications are involved. The necessity of tracking and evaluating air quality or environmental conditions is highlighted by the addition of oxygen, CO2, and NO sensors as well as the digitalization of analog data. To ensure prompt measures, the emphasis on data transmission to a web server and user mobile devices highlights the importance of remote monitoring and the usage of notifications. The document's structure points to a methodical way to combine user communication, network connectivity, and sensor data—signaling an all-inclusive system for safety or environmental monitoring.

All things considered, the document offers a precise and unambiguous set of guidelines for connectinga device to a network, with an emphasis on processing sensor data and notifying users. The detailed procedure shows that sensor thresholds, data transmission, and user engagement have all been carefullyconsidered, indicating a methodical approach to guaranteeing efficient monitor measures. In Fig. 4.1.2 Concise and useful, the document offers step-by-step implementation guidance for a network-connected sensor system with user notifications through the use of specific sensor examples.

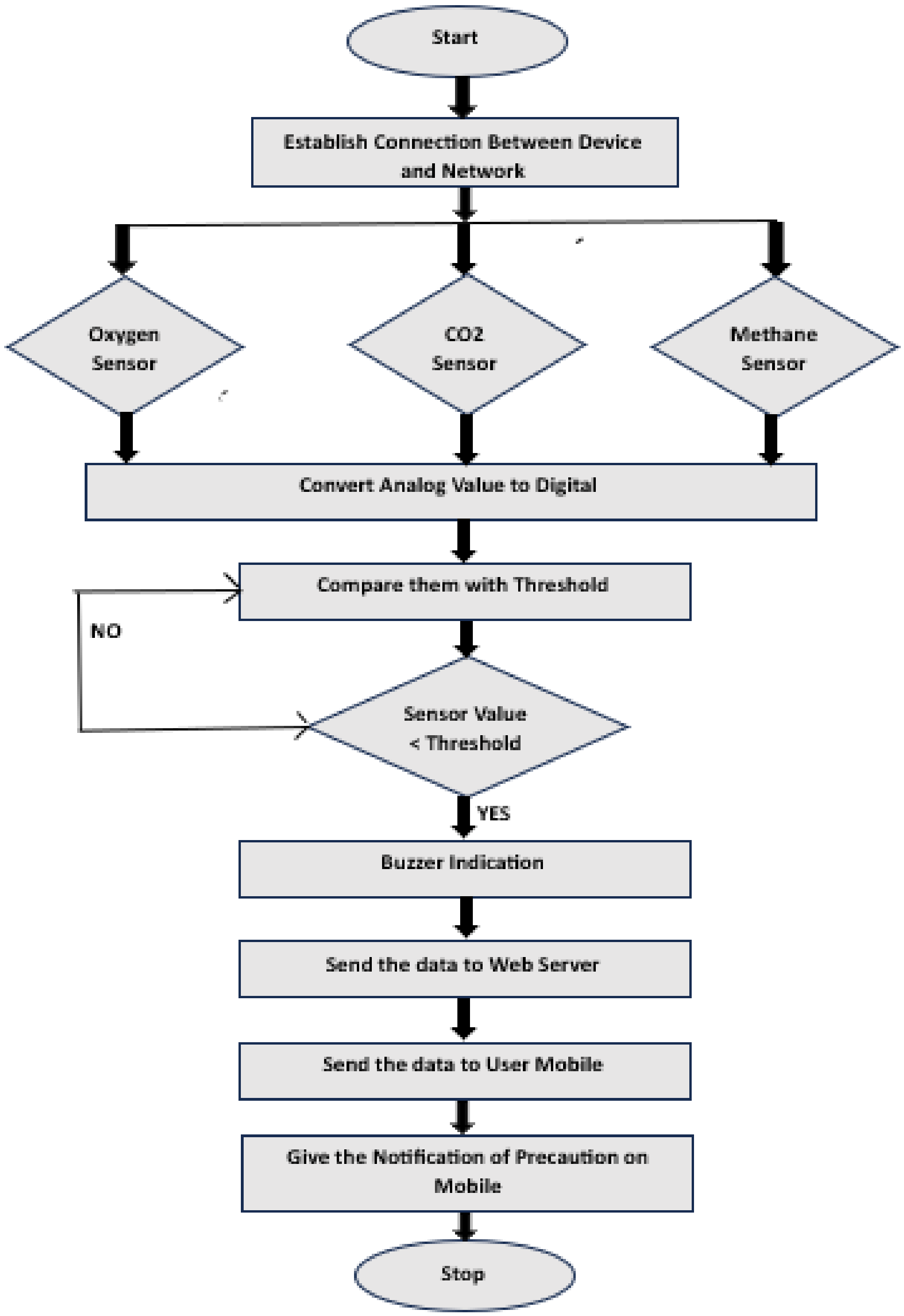

Fig 4.1.2.Flow chart Of system

4.2 Requirement Specification:

A. NodeMCU-ESP32

With the help of the ESP-32 users of the open-source ESP-32 for research purposes and students can interact with electronic modules in accordance with their needs. The functionalities of ESP may be expanded to include external devices. We may change the specifications of electronic gadgets using the ESP-32. Fig. shows the ESP-32. The ESP-32, a versatile microcontroller, serves as a fundamental tool for individuals engaged in research endeavors or educational pursuits, particularly in the field of electronics. Catering to the needs of researchers, students, and enthusiasts alike, this open- source platform offers a wide array of functionalities and capabilities. One of its key features lies in its compatibility with various electronic modules, allowing users to seamlessly integrate and interact with different components based on their specific requirements. Whether it's sensors, actuators, displays, or communication modules, the ESP-32 provides a flexible framework for experimentation and exploration. Moreover, the ESP-32 empowers users to extend its functionalities by interfacing with external devices, thereby broadening its application scope. This capability opens up a plethora of possibilities for innovation and customization, as users can adapt the microcontroller to suit diverse project requirements. Whether it's controlling motors, capturing data from environmental sensors, or communicating with other devices over a network, the ESP-32 serves as a versatile platform for implementing a wide range of electronic applications. Furthermore, the ESP-32 offers the flexibility to modify and tailor the specifications of electronic gadgets to suit specific project objectives. Through its programmable nature and extensive development ecosystem, users can customize the behavior, performance, and functionality of connected devices according to their preferences. This level of flexibility enables researchers and students to delve deeper into their projects, experiment with different configurations, and gain hands-on experience in electronics and embedded systems

In essence, the ESP-32 serves as a foundational tool for individuals seeking to explore the realms of electronics, programming, and IoT (Internet of Things). Its compatibility with various electronic modules, ability to interface with external devices, and flexibility for customization make it an invaluable asset for research, education, and innovation. Whether used in academic settings or professional laboratories, the ESP-32 empowers users to unleash their creativity, push the boundaries of technology, and bring their electronic projects to life.

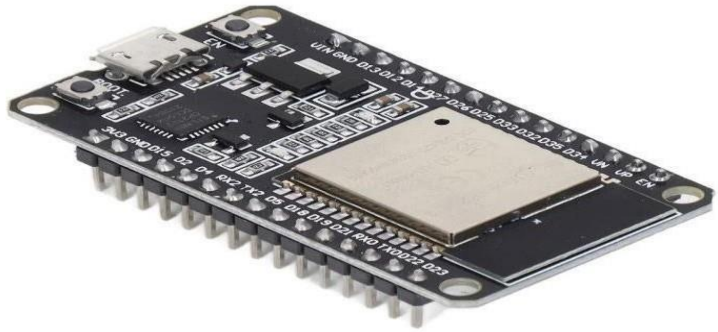

Fig 4.2.1 NodeMCU-ESP32

B. Oxygen sensor:

Oxygen sensors, also known as oxygen gas detectors or O2 sensors, are crucial components in various applications, including industrial settings, medical devices, and safety systems. These sensors measure the concentration of oxygen in the surrounding environment, providing valuable data for ensuring safety, maintaining optimal conditions, or monitoring industrial processes.

Oxygen sensors, Fig. 4.2.2 sometimes referred to as O2 sensors or oxygen gas detectors, are essential parts of many applications, such as safety systems, medical equipment, and industrial settings. By measuring the amount of oxygen present in the surrounding air, these sensors provide useful information that can be used to monitor industrial processes, maintain ideal conditions, or assure safety

Fig 4.2.2 AO-O3 Oxygen sensor

D. Buzzer:

In the world of IoT (Internet of Things), a buzzer is an essential component of a networked ecosystem, offering hearing notifications and alerts to connected systems and devices. A buzzer is easily incorporated into IoT frameworks, making it an adaptable instrument for remote control, automation, and user engagement. Using IoT technology, the buzzer may be controlled and operated remotely via internet-connected devices such as smartphones, tablets, and PCs. Its integration with sensors enhancesits usefulness, allowing it to respond intelligently to a variety of external stimuli or events. For example, a buzzer with motion sensors can serve as an emergency alarm, resulting in when unauthorized activity is noticed.

In industrial environments, IoT buzzers may give real-time notifications for equipment failures or process irregularities, increasing operational efficiency and safety. Furthermore, IoT-enabled buzzers are scalable and flexible, enabling for smooth integration into current IoT ecosystems or new applications. IoT buzzers help to create smarter, more responsive environments in a variety of areas.

Fig 4.2.3 Buzzer

E. LCD display:

LCDs (Liquid Crystal Displays) are essential components of the Internet of Things (IoT) for displayingdata, minimizing human participation, and offering feedback within linked systems. These displaysmay convey a wide range of information, including measurement results and system status updates, as well as alarms and notifications. By incorporating LCD displays into IoT devices, developers can create simple user interfaces that enable users to easily monitor and operate linked systems. These interfaces might be adjusted to individual application requirements, including graphical components and interactive features that cater to user needs. Furthermore, LCD screens support remote monitoring and control of installations of the Internet of Things, allowing users to access data in real time from anyplace using web interfaces or smartphone applications.

Additionally, LCD screens allow remote monitoring and control of IoT deployments, allowing users to view real-time data from anywhere using web interfaces or mobile apps. LCD displays, with their energy-efficient operation and easy interaction with various other components of the IoT, play a significant part in enhancing the functionality, usability, and efficiency of interconnected devices .

Fig 4.2.4 LCD display

F. Wi-Fi Module:

The Wi-Fi module serves as the backbone of connectivity, allowing devices to communicate with one another as well as with the larger internet infrastructure. Its major role is to establish wireless connections to nearby Wi-Fi networks, enable applications to connect to the network without the use ofphysical cords. Once attached, these modules enable data transfer between devices and external servers or cloud platforms, acting as a conduit for exchanging sensor readings, device statuses, and user commands. Security features are critical, and Wi-Fi modules use encryption protocols and authentication processes to protect sensitive data from unwanted access. They additionally include established and use tools, which comfortable operations like network scanning, connection formation, and power optimization. Power efficiency is a cruicial factor for this module Power efficiency is an important factor since these modules are frequently used in battery- powered devices, requiring changes for better battery life without affecting connection. Connectivity with IoT platforms improves development by providing programmers with the tools and resources they require to develop seamless Wi-Fi-enabled mobile applications. In simple terms, the Wi-Fi module provides the basis of a connection in IoT projects, permitting the establishment of linked ecosystems in which devices interact and collaborate to deliver improved features and user experiences.

Fig 4.2.5 Wi-Fi Module

G.MQ-2:

The MQ-2 sensor is an open sensor for gases that is commonly used in applications such as IoT and monitoring the environment systems. It is especially designed for identifying an extensive variety of gases, including but not excluded from methane, propane, butane, alcohol, hydrogen, and smoke. Its functionality depends on the concept of gas detection, involving modifying electric conductivity in the presence of target gases. The sensor comprises a detecting element consisting of tin dioxide (SnO_2) semiconductor, which alters conductivity when exposed to various gas concentrations. As gases interact with the sensing element, their resistance changes, producing a measurable electrical signal corresponding to the gas concentration in the surrounding air.The MQ-2 sensor is equipped with a within heating device which helps maintain its accuracy and quick response. It additionally includes analog and digital output pins, which make it compatible with avariety of microcontrollers and IoT platforms. This sensor has several uses, including resi commercial security systems, air quality monitoring, and gas leak detection. Its small size, cheap cost, and ease of integration make it an attractive option for uses which need dependable gas sensing capabilities. The MQ-2 sensor is equipped with a within heating device which helps maintain its accuracy and quick response. It additionally includes analog and digital output pins, which make it compatible with a variety of microcontrollers and IoT platforms. This sensor has several uses, including residential and commercial security systems, air quality monitoring, and gas leak detection. Its small size, cheap cost, and ease of integration make it an attractive option for uses which need dependable gas sensing capabilities. However, it is crucial to remember that, while the MQ-2 sensor gives useful information on gas concentrations, its accuracy and sensitivity may vary depending on temperature.

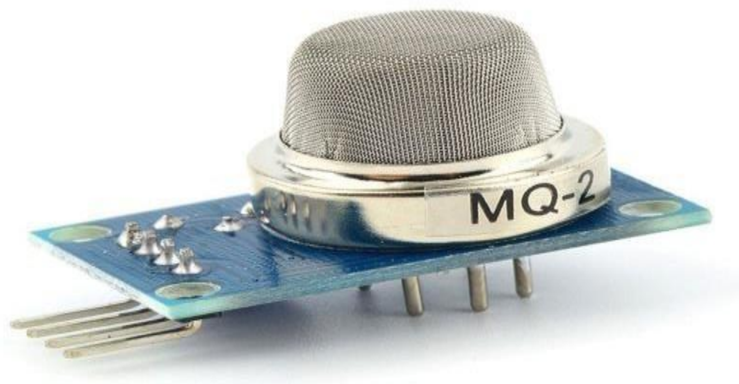

Fig 4.2.6 MQ-2 Sensor

H. MQ-6:

The MQ-6 gas sensor is commonly utilized in a number of connected devices and monitoring the environment systems. It has been designed to detect LPG (liquefied petroleum gas) and butane by measuring modifications to electrical conductivity. The sensor features a tin dioxide (SnO_2) semiconductor detecting device that changes resistivity when subjected to target gases. LPG or butane particles interact with the sensing element, creating changes in conductivity and generating an identified electrical signal appropriate to the gas concentration in the surroundings. The MQ-6 sensor often contains an integrated warming component to maintain a constant working temperature, which improves sensitivity and response time. The MQ-6 sensor frequently includes an integrated heating element to maintain an appropriate working temperature, which enhances sensitivity and response time. With both analog and digital output pins, it is accessible with a variety of microcontrollers and IoT platforms, allowing for smooth integration into IoT applications. The MQ-6 sensor is commonly used in household and commercial gas leak detection systems, which provide safety by quickly acknowledging and alerting users to the presence of dangerous gases. However, it is important to note that, while the MQ-6 sensor has useful gas detection capabilities, its accuracy and sensitivity may be impacted by temperature, humidity. As a result accurate calibration and monitoring of the environment are required to ensure consistent performance in situations in real world.

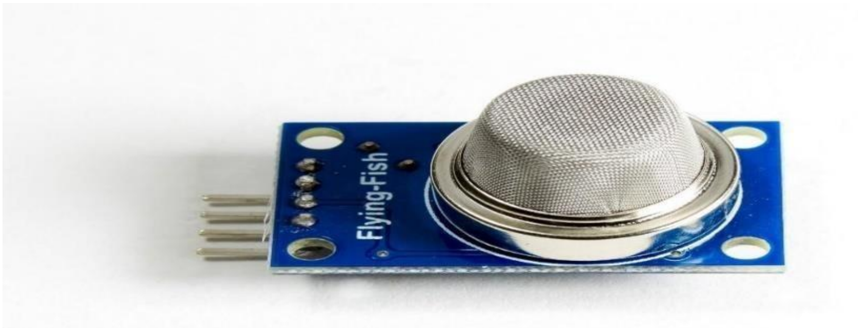

Fig 4.2.7 MQ-6 Module

I. Implementation:

Drainage workers often operate in confined and hazardous environments where the risk of oxygen depletion is a critical safety concern. This paper proposes the development and implementation of a real-time oxygen level detection system specifically tailored to enhance the safety of drainage workers. The system Fig. 4.2.8 integrates advanced oxygen sensors, wireless communication technologies, and intelligent algorithms to continuously monitor and analyze oxygen concentrations in drainage workspaces. The system incorporates highly sensitive oxygen sensors strategically positioned in key locations within drainage systems, manholes, and underground tunnels. These sensors provide real-time measurements, and the collected data is processed using specialized algorithms designed to account for the unique challenges posed by the drainage work environment. The algorithms take into consideration factors such as fluctuating oxygen levels, confined spaces, and potential contaminants that may affect accuracy. Workers in the drainage industry sometimes work in tight spaces with high risks of lack of oxygen, which is a serious safety problem. The goal of this study is to improve the safety of drainage workers by developing and implementing a real-time oxygen level sensing system. The system continually monitors and analyzes the oxygen concentrations in drainage workstations by integrating cutting-edge oxygen sensors, wireless communication technologies, and sophisticated algorithms.

The system uses very sensitive oxygen sensors that are placed at strategic manholes, underground tunnels, and drainage system locations. These sensors offer real-time readings, and the data they gather is analyzed through the use of specialized algorithms that are tailored to the particular difficulties presented by the drainage industry. The algorithms account for variables that may impact accuracy, such as changing oxygen concentrations, cramped quarters, and possible pollutants.

The implementation of the real-time monitoring system for oxygen, temperature, and carbon dioxide detection in manholes has yielded significant results in enhancing safety and improving efficiency in maintenance operations. Through the integration of advanced sensors and communication technology, the system has provided invaluable insights into the environmental conditions within confined spaces, enabling proactive measures to mitigate risks and prevent accidents.

One of the key outcomes of the project is the ability to monitor oxygen levels, temperature fluctuations, and carbon dioxide concentrations in real-time. By continuously tracking these parameters, maintenance personnel can promptly identify hazardous conditions and take appropriate actions to ensure their safety. The system's capability to provide timely alerts has proven instrumental in preventing accidents and minimizing the potential for injuries or fatalities during manhole operations. Furthermore, the real-time monitoring system has facilitated better decision-making and resource allocation in maintenance activities. By accurately assessing environmental conditions within manholes, municipalities and utility providers can optimize the deployment of personnel and equipment, streamline workflow processes, and minimize downtime. Additionally, the system's data logging and analysis features enable post-incident evaluation and the refinement of safety protocols, contributing to continuous improvement in safety standards.

The analysis of the project's outcomes highlights the transformative impact of innovative technologies in addressing safety challenges associated with confined space entry. By harnessing the power of real- time monitoring and data-driven insights, this initiative has not only enhanced the safety of maintenance personnel but also improved the resilience and reliability of urban infrastructure networks. Moving forward, continued investment in such technologies is crucial to ensuring the sustainability andsafety of critical infrastructure systems in urban environments.

Fig 4.2.8 Final Prototype of System

CHAPTER 5

HIGH-LEVEL DESIGN

5.1 Use-case Diagram:

A use case diagram provides in Fig 5.1 a visual representation of how a system interacts with external entities, illustrating various scenarios or use cases. In the context of the real-time oxygen level detection system for drainage workers, the use case diagram outlines the interactions between the system and the key actors involved.

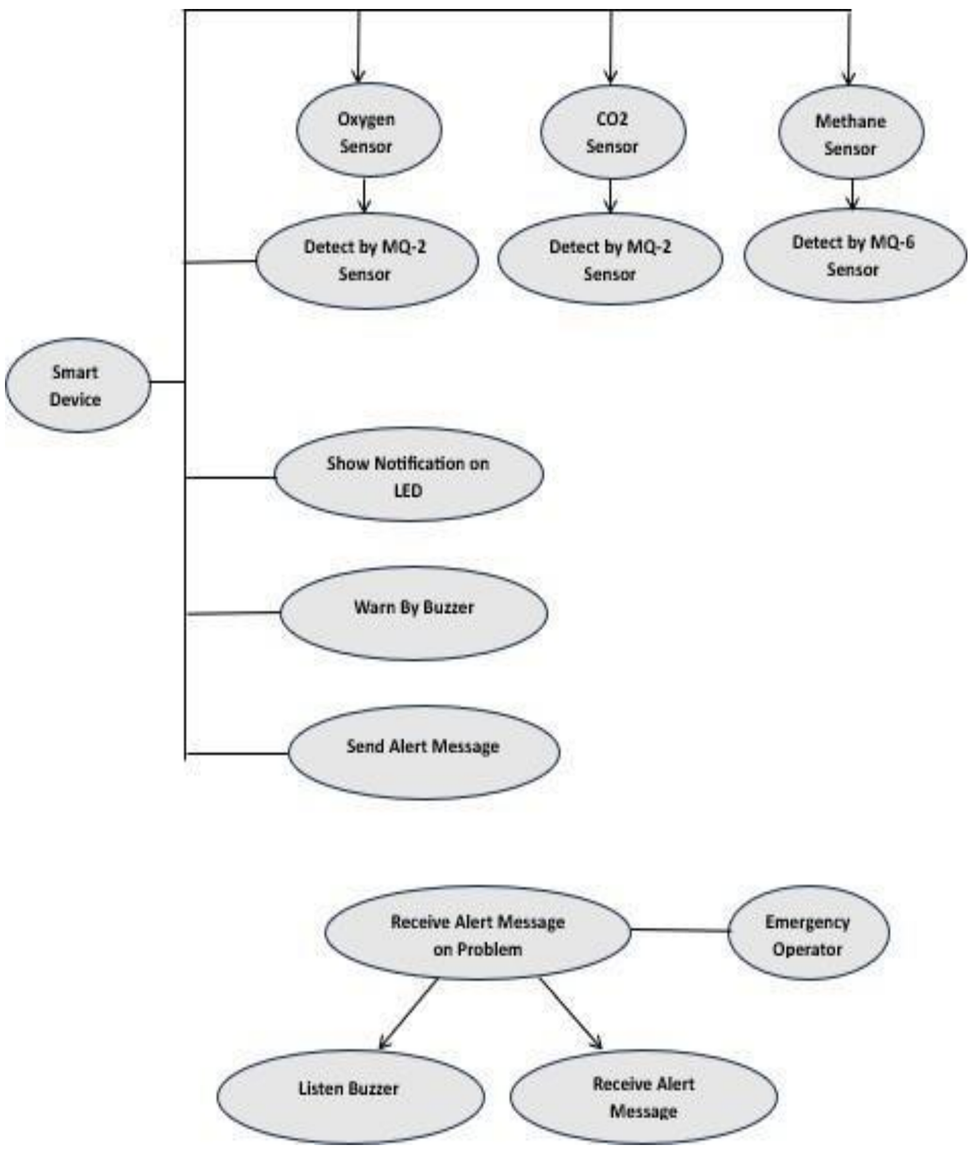

Fig. 5.1 Use case Diagram

5.2 Object Diagram:

An object diagram provides in fig. 5.2 a static view of a system at a specific point in time, showcasing the instances of classes and their relationships. In the context of the real-time oxygen level detection system for drainage workers, the object diagram illustrates specific objects and their relationships during the system's operation.

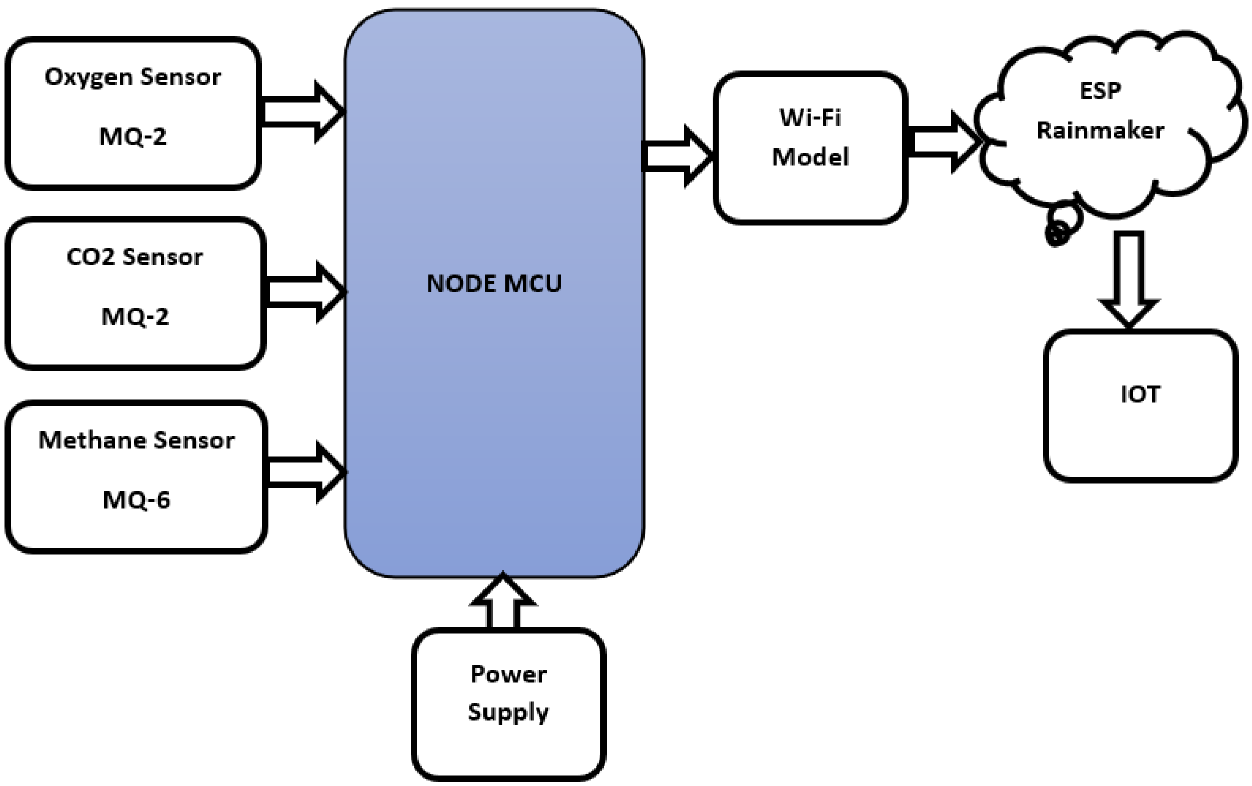

Fig 5.2 Object Diagram

5.3 Sequence Diagram

A sequence diagram displays the interactions of several components or objects in a system through time. In the framework of the real-time oxygen level detection system for drainage workers, the sequence diagram in fig. 5.3 depicts the flow of messages and actions between key actors and system components in an everyday scenario.

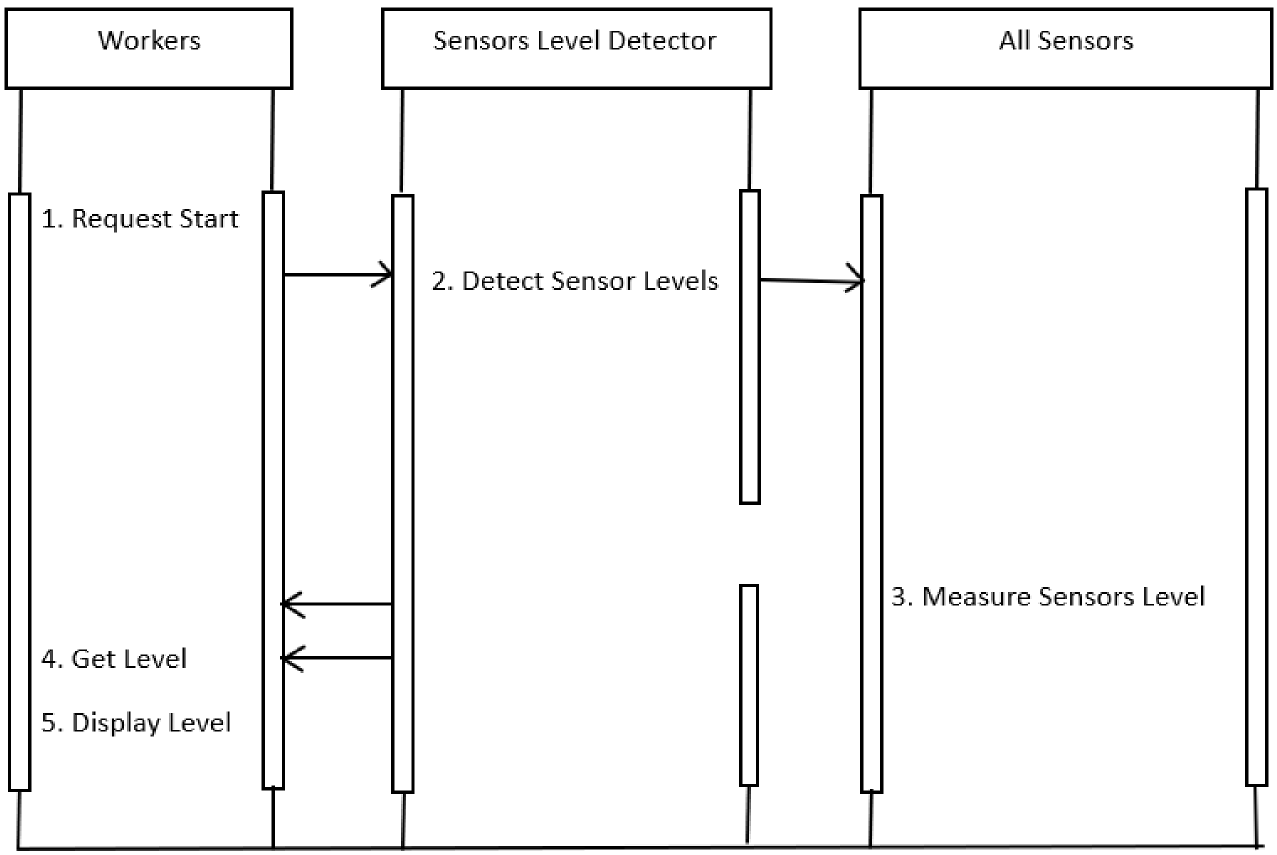

Fig. 5.3 Sequence Diagram

5.4 State Diagram

Initial State: The system starts in this state.

Assess Oxygen Level and Start Work: In this state, the system assesses the oxygen level, and if it'ssafe, the worker starts the drainage system maintenance.

Oxygen Monitoring in Progress: This state represents the ongoing monitoring of oxygen levels duringwork.

Oxygen Level Below Threshold: If the oxygen level falls below the threshold, the system transitions tothe "Alert Worker and Display on LCD Screen" state.

Alert Worker and Display on LCD Screen: The system alerts the worker about the low oxygen leveland displays it on the LCD screen.

Transmit Help-Seeking Message and Wait for Confirmation: If the situation worsens, the systemtransmits a help-seeking message and waits for confirmation from the worker.

Continue Work: If the oxygen level is normal, the worker can continue the maintenance work.

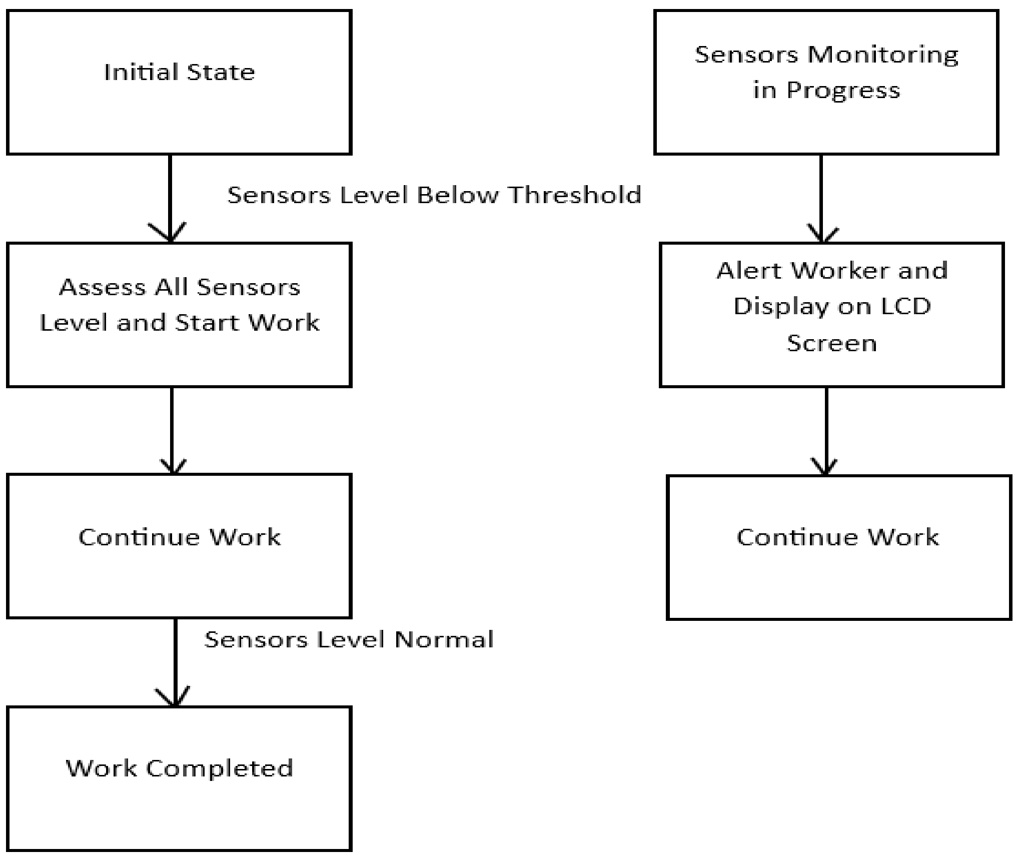

Fig. 5.4 State Diagram

CHAPTER 6

FEASIBILITY STUDY

6.1 Introduction to Feasibility

The feasibility study serves as a critical preliminary assessment to determine the practicality, viability, and potential success of the proposed project, "Real-time Oxygen Level Detection for Enhanced Safety of Drainage Workers." This investigation focuses on evaluating various aspects to ensure that the project aligns with organizational goals, addresses the identified problem effectively, and is economically and technically feasible. The introduction to the feasibility study provides an overview of the project's objectives and the rationale for conducting the study.

Define the boundaries of the feasibility study, specifying the aspects to be analyzed and evaluated. Clarify whether the study will focus on economic feasibility, technical feasibility, operational feasibility, or a combination of these factors.

The introduction to the feasibility study sets the stage for a comprehensive examination of the proposedproject's feasibility. It outlines the motivation behind the study, the specific objectives, and the critical aspects that will be evaluated. This introduction serves as a guide for stakeholders and decision-makers to understand the context and purpose of the feasibility study for the "Real-time Oxygen Level Detection for Enhanced Safety of Drainage Workers" project.

6.2 Economic Feasibility

Conducting an economic feasibility study for the implementation of oxygen level detection systems in manholes involves a meticulous examination of costs and potential benefits. The initial investment comprises expenses related to acquiring and installing oxygen sensors, integrating them into a real-time monitoring system, and, if necessary, developing customized software solutions. Operational costs encompass ongoing maintenance, periodic calibration, and the energy expenditure associated with continuous monitoring. Training programs for personnel on system usage also contribute to the overall cost. On the benefits side, enhanced safety is a primary consideration, potentially leading to a reductionin accidents and fatalities, which could, in turn, result in lowered insurance premiums. Improved operational efficiency, characterized by faster response times to hazardous conditions and minimized downtime due to accidents, adds significant value. Compliance with safety regulations not only ensuresa secure working environment but also positively impacts the company's reputation and stakeholder trust. The return on investment (ROI) analysis is paramount, involving a careful evaluation of the time required for the initial investment to be recovered and a quantification of the various benefits.

Risk analysis, examination of alternative safety measures, sensitivity analysis, and an assessment of long-term viability are critical components of the study. Considerations of legal and regulatory compliance, environmental impact, and social implications, including worker well-being, further enrich the decision-making process. A comprehensive and well-documented report encompassing these factors provides stakeholders with the necessary information to determine the economic viability and potential positive impact of implementing oxygen level detection systems in manholes. This facilitates an informed decision on whether to proceed with the proposed safety enhancement.

6.3 Technical Feasibility

The technical feasibility of implementing an oxygen level detection system in manholes is rooted in a comprehensive examination of various critical components. The first consideration involves evaluating the suitability and availability of oxygen sensors designed for confined spaces, taking into account factors like accuracy, response time, and reliability under diverse conditions. Additionally, the feasibility of real-time data transmission from within manholes is crucial, necessitating exploration of wireless communication technologies for seamless connectivity. Integration with existing monitoring systems or the potential implementation of a new, compatible system must also be considered. Power supply requirements, including energy-efficient solutions and alternative power sources, play a pivotal role in sustaining continuous sensor operation. Environmental factors, such as temperature, humidity, and exposure to hazardous substances, need careful assessment to ensure optimal sensor performance. Calibration frequency, maintenance requirements, and the impact on system downtime are additional considerations, along with the design of an intuitive user interface and effective alert systems. Scalability to accommodate various manhole sizes, durability to withstand harsh conditions, and regulatory compliance with safety standards are paramount. A cost-benefit analysis further determines the economic viability of the technology, considering potential cost savings associated with accident prevention. Finally, establishing mechanisms for user feedback and iterative improvements ensures the ongoing effectiveness of the oxygen level detection system in manholes. In essence, a robust theoretical framework is essential to pave the way for a practical and effective implementation of this safety-enhancing technology.

6.4 Behavioral Feasibility

Assessing the behavioral feasibility of introducing an oxygen level detection system in manholes entails a nuanced examination of how individuals, both workers and stakeholders, interact with and respond to the proposed technology.

Central to this evaluation is the acceptance from the workforce, necessitating an understanding of how readily employees embrace the system and incorporate it into their daily routines. Clear and comprehensive training programs, coupled with effective communication strategies, are pivotal in ensuring that workers comprehend the system's significance for their safety. Usability emerges as another critical factor, demanding a user-friendly interface and intuitive controls that mitigate cognitive load, especially in challenging working conditions. Furthermore, predicting and shaping behavioral changes in response to system alerts becomes imperative, emphasizing the need for tailored training that outlines appropriate responses and emergency procedures to foster a proactive safety culture. Incorporating mechanisms for ongoing feedback from workers is integral, providing insights for iterative improvements and adjustments. Lastly, considering stakeholder perceptions, including investors, regulatory bodies, and the public, is paramount for garnering support and ensuring overall compliance. In essence, a holistic understanding of the human aspects surrounding the proposed oxygen level detection system informs the creation of effective training, communication, and feedback mechanisms, crucial for its successful integration into manhole operations.

6.5 Time Feasibility

The time feasibility of integrating an oxygen level detection system in manholes necessitates a comprehensive evaluation of various temporal considerations throughout the technology's lifecycle. Initial development and installation timelines are critical, encompassing the procurement, customization, and integration of sensors, as well as the deployment of monitoring software and physical system installation within manholes. Efficient project planning hinges on a clear understanding of the time required for these tasks. The deployment phase must be strategically executed, considering factors such as the number of manholes involved, the intricacy of installation, and potential disruptions to ongoing operations. Rapid deployment is paramount to enhancing safety promptly. Additionally, ongoing operational efficiency relies on judiciously managing the time required for routine maintenance, sensor calibration, and system updates. Ensuring that these tasks can be conducted efficiently without causing substantial downtime is crucial for the sustained effectiveness of the system. Simultaneously, the development and execution of training programs for personnel, focusing on system operation and response protocols, contribute to a seamless integration process. Balancing these temporal considerations ensures not only the swift implementation of the oxygen level detection system but also its ongoing functionality and success within manhole operations.

6.6 Resource Feasibility

Conducting a resource feasibility study for the implementation of an oxygen level detection system in manholes involves a comprehensive examination of the various resources required throughout the project lifecycle. From a financial perspective, resources are allocated to the procurement and customization of oxygen sensors, development or integration of monitoring software, and the physical installation of the system. These financial considerations also extend to ongoing operational costs, including maintenance, calibration, and potential upgrades. Additionally, human resources play a crucial role, encompassing skilled personnel for system installation, training, and ongoing maintenance. The availability of suitable technology infrastructure, such as data transmission and connectivity solutions, is another key resource consideration. Furthermore, time is a critical resource, requiring efficient project planning and deployment to enhance safety promptly. Balancing these diverse resources is essential to ensure the successful and sustainable implementation of the oxygen level detection system in manholes, addressing financial constraints, leveraging human expertise, and optimizing technological infrastructure. This resource feasibility study serves as a foundational element for decision-makers, providing insights into the necessary resource allocations and potential challenges associated with integrating this safety-enhancing technology into manhole operations.

CHAPTER 7

Experiment Results

The real time oxygen level detecting system detecting the oxygen level and other gases such as methane ,CO2 and assessment by incorporating a variety of sensors, an Arduino Uno board for data processing, and a ESP RainMaker for easy visualization and control. This system is useful for sewage system for detecting the oxygen level and other gases such methan and CO2 By integrating a diverse array of sensors, an Arduino Uno board for sophisticated data processing, and a user-friendly ESP RainMaker for intuitive visualization and control, this system offers a comprehensive solution to ensure the safety of workers . A real-time oxygen level and other gases detection system provides continuous monitoring and analysis of the surrounding environment. It constantly measures the concentration of gases like oxygen, carbon dioxide, carbon monoxide, and other hazardous gases.The results typically include numerical values indicating the concentration levels of each gas, often displayed on a graphical interface for easy interpretation. Additionally, the system may offer alerts or warnings when gas levels exceed safe thresholds, enabling prompt action to mitigate risks.The detection system integrates sensors for measuring oxygen, CO2, and methane levels within the manhole environment. These sensors are strategically placed to ensure accurate and reliable data collection.The system incorporates an LED display to provide real-time feedback on oxygen levels. The LED display visually represents the current oxygen concentration, allowing workers to easily monitor the environment's safety status.In addition to the LED display, the system includes a buzzer alert mechanism. When oxygen levels exceed predefined safe thresholds, the buzzer is automatically activated, providing an audible warning to workers inside the manhole.The detection system is further enhanced by integrating with the ESP Rainmaker app. This app allows for remote monitoring and management of the detection system from a smartphone . The table provided, showing values of Oxygen, Carbon Dioxide, and Methane across four trials, could be used to enhance safety by monitoring and adjusting the levels of these gases in a particular environment (like a workplace, laboratory, or industrial setting).

1. Oxygen: Essential for breathing and maintaining life, but too high a concentration can promote fires or explosions.
2. Carbon Dioxide: Generally safe in lower concentrations but can cause health issues or suffocation at high levels.

3. Methane: Highly flammable and can be explosive when mixed with air; it is also an asphyxiant at high concentrations.

By observing the trends in these gases:

- An increase in Oxygen levels, as shown from Trial 1 to Trial 4, might enhance safety by ensuring sufficient breathable air, but care must be taken to avoid levels that might support rapid combustion.
- A decrease in Carbon Dioxide and Methane levels could indicate successful mitigation of these potentially dangerous gases. This data can help in implementing safety measures such as ventilation improvements, leak checks, and setting alarms for unsafe gas concentrations. Monitoring and controlling these gas levels are crucial for ensuring environmental safety and preventing hazardous situations.

The table provided is a data matrix consisting of four rows and three columns, excluding the header row. It records the values for three different gases Oxygen, Carbon Dioxide, and Methane across four separate trials:

1. Oxygen
   - Trial 1: 16
   - Trial 2: 25
   - Trial 3: 65
   - Trial 4: 81
2. Carbon Dioxide
   - Trial 1: 75
   - Trial 2: 62
   - Trial 3: 31
   - Trial 4: 15
3. Methane
   - Trial 1: 540
   - Trial 2: 325
   - Trial 3: 500
   - Trial 4: 275

The table shows a pattern where:

- Oxygen levels increase from Trial 1 to Trial 4.
- Carbon Dioxide levels decrease from Trial 1 to Trial 4.

- Methane values also decrease overall from Trial 1 to Trial 4, with a slight increase in Trial 3 compared to Trial 2.

Table 1 : Analysis of Oxygen ,Carbon Dioxide, Methane

Trials	Oxygen	Carbon Dioxide	Methane
Trial 1	16	75	540
Trial 2	25	62	325
Trial 3	65	31	500
Trial 4	81	15	275

The image is a line graph with a vertical axis labeled from 0% to 100% and a horizontal axis labeled with "Trial 1" through "Trial 4." There are three lines on the graph, each representing the levels of a different gas across four trials. The green line represents methane, the blue line represents carbon dioxide, and the red line represents oxygen.

From the graph, we can observe the following trends:

- The methane level (green line) remains constant and very low across all four trials, close to the 0% mark. This suggests that methane is being effectively monitored and maintained at a safe level, which is important as methane is a highly flammable gas that can be dangerous at high concentrations.
- The carbon dioxide level (blue line) shows a slight increase from Trial 1 to Trial 2, then a more significant increase from Trial 2 to Trial 3, and remains stable from Trial 3 to Trial 4. The levels are moderate, ranging between approximately 10% and 20%. Monitoring carbon dioxide is crucial for safety as high concentrations can lead to health issues such as headaches, dizziness, and in extreme cases, asphyxiation.
- The oxygen level (red line) starts just above 20%, decreases slightly in Trial 2, then increases in Trial 3 and continues to rise in Trial 4, ending just below 30%. Oxygen levels are critical to monitor for safety purposes, as both too low and too high concentrations can be dangerous. Low oxygen levels can lead to hypoxia, while high levels can increase the risk of fire and explosion.

For safety purposes, it is important to ensure that oxygen levels are maintained within a safe range (typically around 19.5% to 23.5% in occupational settings), carbon dioxide levels are kept low to prevent toxicity and methane levels are controlled to prevent the risk of explosion. The graph suggests that the monitoring system is effectively tracking the levels of these gases, and adjustments are likely being made to maintain safe conditions.

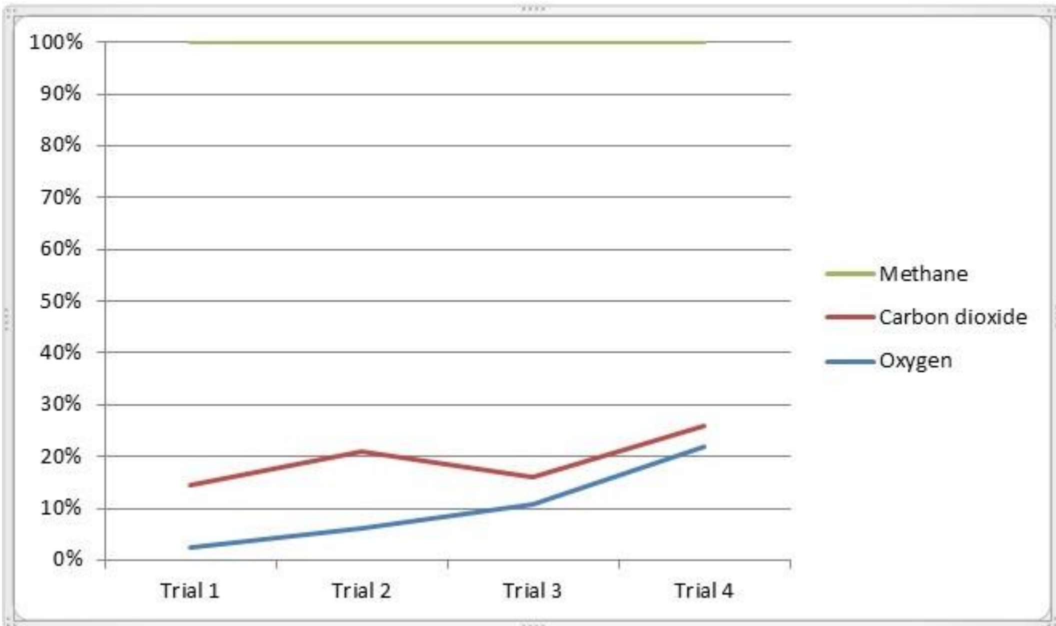

Fig. 7.1 Analysis of Oxygen level Detection system

This table can be used to analyze trends, compare the behavior of different gases across the trials, or calculate statistical data such as averages or variances. When the system detects high oxygen levels triggering the buzzer alert, it simultaneously sends notifications to the ESP Rainmaker app. These notifications provide real-time updates to authorized personnel, alerting them to the hazardous conditions in the sewage.The ESP Rainmaker app provides a user-friendly interface for viewing sensor data, receiving alerts, and controlling the detection system remotely. Authorized users can access the app to monitor the environment's safety status and take necessary actions as needed.By combining sensor technology, LED display, buzzer alerts, and ESP Rainmaker app integration, the detection system enhances safety protocols for workers entering the sewage environment. It ensures timely notification of hazardous conditions, allowing for prompt response and mitigation measures.The integration of sensors, LED display, buzzer alerts, and ESP Rainmaker app notifications creates a comprehensive detection system for monitoring oxygen, CO_2, and methane levels in manholes. This system significantly improves worker safety by providing real-time feedback and alerts, both locally and remotely, ensuring a proactive approach to maintaining safe working environments in sewage infrastructure maintenance.

Fig. 7.2 Model Image 1

In fig 8.2 a scenario is presented where sensors detecting the real time oxygen level and methane, CO_2gases of the environment . the real time oxygen level is 81% and methane level is 158 ppm and CO_2 level is 14% . This level is safe because oxygen level is normal and methane level is also be normal.

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Fig. 7.3 Model Image 2

In fig 8.3 a scenario is presented where sensors detecting oxygen level and methane, CO2 gases on bottle. In this scenerio oxygen level is below such as 5% and methane level is 334 ppm and CO2 levelis 90%. If the oxygen level and other gases level is below then it gives the alert message on ESP RainMaker app and actively alert the buzzer.

CHAPTER 8

CONCLUSION

Real-time oxygen level detection for drainage workers is a crucial step toward enhancing their safety in hazardous work environments. The risks associated with working in confined spaces, such as drainage systems, underscore the need for advanced monitoring systems that can provide immediate alerts and facilitate prompt responses to potential dangers. By integrating real-time oxygen level detection technology into the work environment, we can significantly reduce the likelihood of oxygen-related incidents and ensure the well-being of drainage workers. The ability to continuously monitor oxygen levels allows for early detection of potential hazards, enabling workers to take necessary precautions or evacuate the area promptly. This technology not only serves as a preventive measure but also enhances the overall efficiency and effectiveness of safety protocols. The instant notifications generated by the real-time monitoring system enable quick decision-making by both workers and supervisors, leading to a more proactive approach to safety management. Furthermore, the implementation of real-time oxygen level detection aligns with a broader commitment to worker welfare and occupational safety standards. It demonstrates a dedication to creating a work environment that prioritizes the health and safety of drainage workers, reducing the occurrence of accidents and long-term health issues related to oxygen deficiencies. The senser unit automatically detects all parameters, including the temperature and humidity in the manhole drainage system, as well as the oxygen level, poisonous gas, and water flow rate. This project approach minimizes manpower while increasing safety and the rate of work. All of the information suggested above can be obtained easily with a single click.

In conclusion, the implementation of a real-time monitoring system for oxygen, temperature, and carbon dioxide detection in manholes represents a crucial step towards enhancing the safety of maintenance operations in urban infrastructure management. By addressing the current challenges associated with confined space entry, including the risks of accidents, injuries, and exposure to hazardous gases, this project aims to safeguard the well-being of maintenance personnel and ensure the uninterrupted functionality of essential utility networks. Through the integration of advanced sensors and communication technology, coupled with proactive safety measures, the proposed system offers a comprehensive solution to mitigate the inherent risks of manhole operations.

The safety system for sewage workers is crucial to the worker's survival our project help to reduce the problem of drainage worker safety, with the help of sensors like an oxygen sensor, temperature, humidity and CO2 sensor. Implementing real-time oxygen level sensors in manholes improves safety by providing workers with timely alerts about potentially hazardous conditions. This proactive strategy reduces the risk of asphyxiation and assures the safety of workers in restricted places. Furthermore, by incorporating such technologies into safety practices, firms may demonstrate their commitment to putting worker safety and regulatory compliance first. Overall, this study demonstrates the need to use technology to address major safety issues in industrial settings.

Furthermore, by providing real-time insights into environmental conditions within manholes, the monitoring system enables prompt responses to potential hazards, reducing the likelihood of accidents and improving emergency preparedness. Enhanced safety protocols, including adequate ventilation, proper lighting, and regular maintenance, are essential components of a holistic approach to ensuring the safety and efficiency of manhole operations. As urban infrastructure continues to evolve, prioritizing the safety of maintenance personnel remains paramount, and the adoption of innovative technologies such as real-time monitoring systems represents a significant stride towards achieving this goal. Through collaboration between stakeholders, including municipalities, utility providers, and technology developers, we can create safer working environments and uphold the integrity of critical infrastructure networks for the benefit of society as a whole.

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CERTIFICATE OF PAPER PRESENTED

Appendix A: Certificate of Avishkar Competition

Dr. Babasaheb Ambedkar Technological University, Lonere

AVISHKAR 2023-24

This certificate is presented to

Aishwarya Avinash Patil

for participation in Institute level **Avishkar 2023-24** (Research Competition) held at ***SVKM's Institute of Technology, Dhule*** on 03rd Nov. 2023.

Participation level: **UG**

Discipline :Engineering and Technology

Prof. Dattatray Doifode
Institute coordinator

Dr. Nilesh Salunke
Principal
SVKM IOT, Dhule

Dr. Babasaheb Ambedkar Technological University, Lonere

AVISHKAR 2023-24

This certificate is presented to

Revati Balu Patil

for participation in Institute level **Avishkar 2023-24** (Research Competition) held at ***SVKM's Institute of Technology, Dhule*** on 03rd Nov. 2023.

Participation level: **UG**

Discipline :Engineering and Technology

Prof. Dattatray Doifode
Institute coordinator

Dr. Nilesh Salunke
Principal
SVKM IOT, Dhule

Dr. Babasaheb Ambedkar Technological University, Lonere

AVISHKAR 2023-24

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for participation in Institute level **Avishkar 2023-24** (Research Competition) held at ***SVKM's Institute of Technology, Dhule*** on 03rd Nov. 2023.

Participation level: **UG**

Discipline :Engineering and Technology

Prof. Dattatray Doifode
Institute coordinator

Dr. Nilesh Salunke
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Mayuri Rajendra Tise

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Participation level: **UG**

Discipline :Engineering and Technology

Prof. Dattatray Doifode
Institute coordinator

Dr. Nilesh Salunke
Principal
SVKM IOT, Dhule

Appendix B: Proof of Submission

Submission Confirmation for Real-time Oxygen Level Detection in Manhole to Enhanced the Safety (adem.202401118) Inbox

Advanced... 2:37 pm
to me

Dear Real-time Oxygen Level Detection in Manhole to Enh Bhandari,

Your submission entitled "Real-time Oxygen Level Detection in Manhole to Enhanced the Safety" has been received by journal Advanced Engineering Materials. The manuscript number for your submission is adem.202401118.

To view your submission, please login to https://www.editorialmanager.com/aem-journal/ by entering your username (latika2002) and password and selecting the "Author Login" option.

If the manuscript is accepted for publication, this author's affiliation will be used to determine eligibility for some open access funding (click here for details).

This journal offers a number of license options; information about this is available here. The submitting author has confirmed that all co-authors

Journal Advanced Engineering material

[VJST] Submission Acknowledgement, Id 20755 Inbox

Secretary,... 1:16 pm
to me

Dear Latika Bhandari,

Thank you for submitting the manuscript, "The Real-time Oxygen Level Detection in Manhole to Enhanced the Safety : Oxygen Level Detection in Manhole to Enhanced the Safety " to Vietnam Journal of Science and Technology. With the online journal management system that we are using, you will be able to track its progress through the editorial process by logging in to the journal web site:

Manuscript URL: https://vjs.ac.vn/index.php/jst/authorDashboard/submission/20755
Username: latika2002

If you have any questions, please contact me. Thank you for considering this journal as a venue for your work.

Secretary, Mrs Le Thien Huong

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Appendix C: Research Paper

Real-time Oxygen Level Detection in Manhole to Enhanced the Safety

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Abstract
In many developing countries, like India, the sewage infrastructure is essential to daily life. Upkeep of the drainage system is the responsibility of town personnel. When workers enter the sewage system, the municipality has an obligation to protect their health and well-being. It's essential to comprehend the process and the jobs that the staff members are carrying out. Maintaining ecological balance, sustaining life, and ensuring the health of several ecosystems depend on regulating the amount of oxygen in the atmosphere. "Real-time Oxygen Level Detection in Manhole to Enhanced Safety" is an all-inclusive real-time oxygen level monitoring system designed to use the Internet of Things to improve drainage safety protocols in a range of circumstances. By combining innovative sensor technology, data processing, and simple user interfaces, the system offers precise and quick oxygen level monitoring. The design helps in determining the oxygen levels since the worker in the drainage system can see where he needs to start. The worker can see the oxygen levels on the Screen. The oxygen level in a manhole may be determined using the display panel. Once the worker has entered the manhole to evaluate his condition, the oxygen threshold limit value may be obtained. The signal is sent by the user interface as a help-seeking message. The abstract focuses into the data handling abilities and network connectivity of Internet of Things-based oxygen sensors. Efficiency and simplicity will be the design principles for the system's user interface. With user-friendly interfaces, users may access notification logs, and current oxygen level statistics.

Keywords* —: *IoT*, Drainage monitoring system, IOT, Monitoring smart city, accidents, Oxygen sensor, *Internet of Things, Blynk app.

I.Introduction

Confined spaces such as manholes pose inherent safety challenges due to factors like limited ventilation, fluctuating oxygen levels, and potential accumulation of hazardous gases. To address these risks, the implementation of a real - time monitoring system becomes imperative. This project aims to develop a robust solution for continuous monitoring of oxygen levels, temperature, and carbon dioxide concentrations within manholes, ensuring the safety of workers and preventing potential accidents.Manholes play a role, in maintaining city infrastructure and utility services as they provide access to networks for inspection, upkeep and repairs. However working in these spaces can be dangerous for workers due to their confined and often unsafe conditions. The well-being of employees working in manholes depends greatly on oversight and sporadic checks, which do not keep pace with changing on-site conditions. Poor air quality, high or low temperatures, and harmful gases like carbon dioxide pose serious health risks. Manholes provide access to crucialunderground services like phone lines, power cables, and sewers and often appear as round structures embedded in pavements or streets. Regular upkeep of these essential services is critical for their function and public safety. However, manholes are associated with dangers such as limited ventilation, tight spaces, and potential toxic gas
accumulations from rotting organic matter or chemical waste.

Inspection, cleaning, and repair are just a few of the maintenance duties that go into manholes. Workers who perform these operations frequently have to enter confined spaces, which exposes them to a variety of risks. Accidents and health risks, such as asphyxiation, heat exhaustion, and exposure to poisonous gases, can result from inadequate ventilation and the lack of real-time monitoring systems.

Sustaining the functionality of subterranean utility networks requires regular manhole maintenance. Conventional maintenance methods, however, frequently require workers to manually enter data, putting them in dangerous situations. Insufficient lighting within manholes also makes maintenance and inspection procedures more difficult, which raises the possibility of mishaps. The accumulation of silt and debris in manholes complicates cleaning and maintenance procedures and raises additional and raises additional safety issues.

Insufficient illumination is a major obstacle encountered during manhole operations. Workers find it challenging to assess their surroundings and identify potential hazards when there is poor illumination. Cleaning manholes also presents additional difficulties because of the risks to workers' health and safety posed by accumulated debris, wastewater, and toxic substances.

Aiming to reduce the risks connected with manhole entry are current safety measures like safety protocols and periodic atmospheric testing. Though they may not offer real-time insights into shifting environmental conditions within the cramped space, these measures do depend on manual intervention. Thus, to improve worker safety when entering manholes, a sophisticated monitoring system that can continuously measure temperature, carbon dioxide concentrations, and oxygen levels in real-time is desperately needed.

Developing a thorough monitoring system that can detect and notify users in real time about temperature changes, carbon dioxide concentrations, and oxygen levels inside manholes is imperative in order to resolve these problems. By delivering prompt alerts and facilitating preemptive actions to reduce the risks connected with entering confined spaces, such a system would greatly improve worker safety. Through the incorporation of cutting-edge sensors and communication technologies, this project seeks to transform safety procedures in manhole maintenance operations, guaranteeing the welfare of laborers and the continuous operation of vital urban infrastructure.

Our proposal for this project is to create and put into place a real-time monitoring system that is especially designed to handle the safety issues related to manhole entry. Our goals are to increase operational efficiency, strengthen safety procedures, and protect the health and safety of maintenance workers in confined spaces by incorporating cutting-edge sensors and wireless communication technology.

II. Literature Survey

[1] In 2021, the researchers G. Ramesh, D. A. Kumar, P. M. Khan, G. V. K.Teja and B.Singh worked on a new device called an Electronic Sniffing Mask that purports to improve the safety of sewage workers by constantly detecting unsafe fumes in real-time.Currently available systems feature sensors that can detect different poisonous gasses found in sewage surroundings.If dangerous levels are identified, the mask sends alerts to warn employees so that they can respond appropriately.Alternatively, the mask can be connected to central monitoring system to facilitate remote supervisions of employee’s safety standards.To guarantee healthy lives for sewerage staffs during their operations (Ramesh et al., 2021). [2] In 2022, The authors R.Dronavalli, K.Seelam,P.Maganti,J.Gowineni,and S.D.Challamalla sought after Improved Safety of Sewer Workers with Automatic Manhole Observant Using Internet of Things(IoT) Based System.The system incorporates sensors which determine parameters such as gas levels, temperature,humidity and toxic substances presence within it.IoT-based technology is used to monitor and detect potentially hazardous situations in manholes; this is possible through its combination with sensor networks for example measuring data such as CO_2 levels and temperature .[3] In 2023, K. Ravi Kumar, G. Jagan Mohan, P. Devi Vara Prasad, G. Rohin Kumar and K Vijaya Lakshmi investigated this with The Smart Manhole Monitoring System

as an advanced method aimed at improving manhole inspection and maintenance safety and effectiveness. This system includes a combination of different sensors and IoT technology that monitors diverse information like gases levels, temperature, moistures and water level in the sewers continuously.A real-time data collection and analysis system easily detects potential hazards such as poisonous gases, flooding, or any other abnormal conditions. Once recognized, the system consequently notifies relevant personnel making them take prompt actions to avert accidents or damages.In addition the Smart Manhole Monitoring System through data analytics can offer valuable insights that help optimize maintenance schedules, track trends and enhance infrastructural management practices on an overall basis.It is this systems aspiration to minimize workers' risks, enhance operational efficiency and make manholes last for long in ensuring that they are safer places to work in and urban environments that are more sustainable.

[4] In 2023 D. Mishra, I. Dushettiwar, P. Rane & S. Daware worked on Manhole Monitoring And Detection Using IoT.The objective of this research paper was to present a complete system which can improve safety and maintenance efficiency of manholes.This IoT technology based system is used for monitoring different parameters like gas levels within manholes; temperature and humidity; water levels etc.Sensors integrated with communication modules collect real-time information from the manholes which then gets sent directly as monitored signals to a main control room.[5]In 2022, J. Zhang and X. Zeng authored The research paper "Design of Intelligent Manhole Cover Monitoring System Based on Narrow Band Internet of Things" that looks at a sophisticated design for monitoring manholes with narrowband Internet-of-Things (NB-IoT). For example, in order to find out if they are open or closed or interfered with sensors using NB-IoT technology built into the covers collect real-time information about them while transmitting it wirelessly to a central monitoring platform which helps remote authorities monitor manhole cover conditions. It offers a range of benefits such as improved surveillance efficiency through easy detection of unauthorized entry or tampering, proactive maintenance scheduling leading to reduced maintenance costs among others by integrating NB-IoT technology. In conclusion, this paper provides a strong solution for improving urban infrastructure management and security mainly in preventing damage to the sewer system caused by stolenmanhole covers. [6] In 2022 Y. Liang, L. Chen and B. Xu, worked on Design of Intelligent Management System for Manhole Cover presents a comprehensive approach to managing manhole covers efficiently and intelligently. The system integrates advanced technologies to monitor the status and condition of manhole cover.

[7] In 2021, Y. Xie, H. Wang, J. Liu, R. Zhang, and Y. Guo conducted research on a working monitoring system for manhole wells. Based on Internet of Things technology, provide a full description of a monitoring system meant to oversee the functionality and condition of manhole wells. The system uses the Internet of Things (IoT) to collect real-time data from sensors put in manhole wells. These sensors can monitor a variety of characteristics in manhole wells, including water level, gas concentrations, temperature, and humidity. The collected data is wirelessly transferred to a central monitoring station or cloud-based platform and analyzed in real time. Using data analytics techniques, the system can detect anomalies like flooding orin the presence of hazardous gasses, and instantly notify maintenance workers. The study report will most likely go into detail on the monitoring system's design, implementation, and performance evaluation, covering hardware components, communication protocols, data processing algorithms, and user interface. The study paper advances infrastructure management methods by presenting an IoT-based monitoring system specifically designed for manhole wells, with the goal of improving operating efficiency, preventing accidents, and ensuring worker safety.

[8] V. S. A, S. R, V. S., and A. K collaborated in 2022 to develop manhole cover detection and continuous monitoring of hazardous gases utilizing WSN and IoT technology. They offer a complete approach for improving safety and efficiency in urban infrastructure management, with a focus on manhole covers and hazardous gas monitoring. To achieve its objectives, the system makes use of Wireless Sensor Networks (WSN) and the Internet of Things (IoT). It employs sensors on manhole covers to determine their condition (open or closed) and monitors the surrounding environment for harmful gases such as methane, hydrogen sulfide, and carbon monoxide. The data obtained by the sensors is wirelessly transferred to a central control unit or cloud -based platform via IoT connectivity.

[9] In 2023, M. S., A. R., A. A. N., and A. A. collaborated on "IoT Based System for Manhole Monitoring and Management," which describes a comprehensive solution to the issues connected with manhole monitoring and management in urban areas. This system uses Internet of Things (IoT) technology to track the state and condition of

manholes in real time. It includes a variety of sensors, including proximity sensors, temperature sensors, and gas sensors, that are put within or around manholes to collect data on factors such as cover status, temperature, and gas levels. The collected data is wirelessly transported to a central management platform, where it is processed, analyzed, and presented to stakeholders. This software allows authorities to remotely monitor the condition of manholes and receive alerts in case of anomalies (such gas leaks or open covers), and effectively oversee maintenance programs. In addition to lowering the possibility of accidents and infrastructure damage, this technology also improves worker and public safety and increases operational efficiency through proactive maintenance techniques.

[10] Researchers Y. Nandini, K. V. Lakshmi, T. I. S. Srujan, M. Yasswi, and K. S. Jagadish worked on the research paper "Design of Real-Time Automatic Drainage Cleaning and Monitoring System using IoT" in 2023. The paper describes the development of an inventive system that uses Internet of Things (IoT) technology to improve the efficacy and efficiency of drainage cleaning processes. This technology allows for the real -time monitoring of drainage systems by integrating sensors and IoT devices. These sensors gather information on a number of variables, including water levels, flow rates, and obstructions in the drainage system. The technology uses this information to automatically identify possible obstructions or problems in the drainage system and starts cleaning procedures right away. Additionally, it has the ability to send notifications and alerts to authorities or maintenance staff when anomalies are found, making timely action possible. The design and implementation aspects of the system, such as sensor selection, communication protocols, data processing algorithms, and user interface, are probably covered in the study paper.

[11] The Smart Drainage and Health Monitoring System of Manual Scavenger using Internet of Things (IoT) was developed in 2021 by S. P. K. Ramadhin, S. Anand, R. Aishwarya, and Y. R. It offers a novel way to enhance the security and welfare of manual scavengers operating in drainage systems through the use of IoT technology.This system combines sensors and Internet of Things devices to track the health metrics of manual scavengers as well as the drainage environment in real time. By gathering information on variables like temperature, humidity, flow rates, and gas concentrations, sensors installed in the drainage system enable the early identification of potentially dangerous situations. Furthermore, manual scavengers are outfitted with wearable health monitoring devices to check vital indications like heart rate, body temperature, and oxygen saturation levels. This makes ongoing keeping an eye on their health while working in potentially dangerous conditions. The gathered data is wirelessly transferred to a central monitoring platform for analysis. In the event of abnormal situations, automated notifications can be created, enabling prompt response to guarantee the security of manual scavengers.of monitoring systems powered by IoT. This method has the ability to greatly lower the dangers involved with manual scavenging and enhance the general health and safety of field personnel.

[12] The Smart System for Hazardous Gases Detection and Alert System utilizing Internet of Things, developed in 2021 by R. S. Ganesh, M. Mahaboob, J. AN, L. C, P. S, and K. K. Kuma, describes a comprehensive system to improve safety in areas where hazardous gases may be present. The system uses Internet of Things (IoT) technology to continuously monitor and identify dangerous gas levels.This system has sensors that can identify a number of dangerous gases, including carbon monoxide, hydrogen sulfide, and methane. These sensors are positioned carefully in areas like mines, restricted spaces, and industrial sites where there is a high risk of gas exposure or leaks.Wireless transmission of the sensor data to a central monitoring platform or control room through Internet of Things protocols. The platform continuously checks for abnormal gas levels by processing and analyzing the data in real - time. The device automatically warns necessary workers or authorities when dangerous gas levels surpass predefined parameters. This makes it possible to take preventative action and swift action to safeguard worker and environmental safety.The design, implementation, and performance evaluation of the smart gas detection and warning system, including sensor selection, communication protocols, data processing algorithms, and user interface, are probably covered in full in this research article.

[13] The Iot Based Drainage and Waste Management Monitoring and Alert System for Smart City, developed in 2021 by M. Aarthi and A. Bhuvaneshwaran, offers a comprehensive solution to the problems associated with managing urban infrastructure in smart cities. The suggested solution makes use of Internet of Things (IoT) technologies to provide real-time monitoring and control of waste management and drainage systems. It combines a

number of sensors that are dispersed across the infrastructure of the city to gather information on variables including water levels, flow rates, garbage bin fill levels, and ambient temperatures. IoT connection methods are used to wirelessly transfer the sensor data to a centralized monitoring platform. In order to find abnormalities and possible problems with the waste management and drainage systems, the platform evaluates the data and uses analytics algorithms. The system's alert function, which instantly alerts pertinent parties, including city officials or maintenance staff, when anomalies or urgent circumstances are discovered, is one of its most important aspects. This makes it possible to respond quickly and take action to stop or lessen possible issues.

[14] In 2018, Dhanalakshmi.G, Akhil.S, Francisca Little Flower.M, and Haribalambika.R developed an Explosion Detection and Drainage Monitoring System using Automation. The system addresses safety and efficiency concerns in industrial contexts by integrating automation technology. This paper's proposed system combines explosion detection capabilities with drainage monitoring functionality to provide a comprehensive approach to safety and maintenance. The system will most likely include a variety of sensors capable of detecting changes in gas levels, temperature, and pressure, all of which are common signs of possible explosions. These sensors continuously monitor the surroundings and provide information to a central control system. In addition to explosion detection, the system also has drainage monitoring capabilities. Sensors are put throughout the drainage network, monitoring characteristics such as flow. Rates, liquid levels, and possible obstructions. Any anomalies discovered in the drainage system are promptly reported to the central control system. The central control system processes data from both explosion detection sensors and drainage monitoring sensors in real time. It analyzes the data and initiates appropriate responses, such as triggering safety protocols in the event of an explosion or notifying maintenance people about drainage concerns.

[15] This research article appears to focus on an IoT-based system aimed to improve the safety of sewage workers by automatically monitoring manholes. This system will most likely use sensors and IoT technology to monitor manhole conditions and deliver real-time data to maintain worker safety. It is a critical field of research since it addresses the safety concerns of those who work in sewage systems. [16] The purpose of this research paper is to investigate the development of a smart city application using Raspberry Pi and IoT technologies to monitor many elements of urban life. This would most likely include deploying sensors and devices connected to Raspberry Pi boards to collect data on parameters such as air quality, traffic flow, noise levels, waste management, etc energy consumption. The collected data is then processed and analyzed to provide insights that can be used to optimize city services and improve the quality of life for residents. By leveraging IoT and Raspberry Pi, the goal is to create a cost-effective and scalable solution for building smarter and more sustainable cities.

[17] The research article focuses on creating an IoT-based smart drain monitoring system with alarm messaging capabilities. This method most likely entails installing sensors in drains to monitor characteristics such as water level, flow rate, and quality. The sensors send data to a central control unit or cloud platform, which processes and analyzes it in real time. If abnormal conditions are recognized, such as a rise in water level signaling potential flooding, the system sends alert messages to the appropriate authorities or stakeholders via SMS or other communication channels. The purpose is to give early warnings and prompt response to reduce the hazards associated with drainage issues including urban flooding and environmental pollution.

[18] This research article focuses on creating an edge computing-based intelligent manhole cover management system for smart cities. This system is expected to include sensors and computer equipment placed directly on or near manhole covers to monitor characteristics such as temperature, pressure, and movement. The edge computing architecture allows for real-time processing and analysis of data acquired directly from these sensors, decreasing latency and bandwidth needs. The system may use machine learning algorithms to detect abnormalities or patterns that indicate possible problems, such as illicit access, obstructions, or structural deficiencies in the manhole covers. When anomalies are found, the system can generate alerts or messages to relevant authorities or maintenance workers, allowing for prompt response and intervention.

[19] This research study focuses on creating a smart drainage system with Zigbee and IoT technology. This system most likely entails installing Zigbee-enabled sensors and devices in drainage infrastructure to monitor characteristics such as water level, flow rate, and quality. The Zigbee protocol allows for low-power, short-range wireless communication between these sensors and a central control unit or gateway. The sensors gather data on drainage

conditions and send it to the control unit in real time. The control unit, which may be connected to the internet, collects and analyzes the data collected from the sensors. It can detect irregularities or prospective problems, such as blockage, flooding, or pollution occurrences. When anomalies are found, the system can provide warnings or notifications to relevant stakeholders, such as city officials.or maintenance people, using IoT platforms or mobile apps.The purpose of this study is to create an efficient and dependable smart drainage system that may improve the management and maintenance of urban drainage infrastructure, thereby contributing to the resilience and sustainability of smart cities.

[20] research article focuses on developing a supervision and management system for ownerless manhole covers using RFID technology. To uniquely identify and track manhole covers, this system will most likely include inserting RFID tags or chips.RFID tags connect wirelessly with RFID readers positioned in key locations, such as city roadways or sewer networks. These readers can detect the existence and location of manhole covers in real time.[21] This research article focuses on creating an IoT-based sewage monitoring system. This system most likely entails installing sensors and devices in sewage infrastructure to monitor characteristics such as flow rate, volume, temperature, pH levels, and contaminant concentrations.The sensors gather real-time data on sewage conditions and wirelessly send it to a central control unit or cloud platform.

[22] This research article focuses on creating an automated Internet of Things (IoT) system for monitoring underground drainage and manholes in major cities. This system most likely combines multiple IoT devices and sensors installed in underground drainage networks and manholes to monitor critical factors such as water level, flow rate, temperature, and structural integrity.The IoT devices capture real-time data from the subsurface infrastructure and send it wirelessly to a central control unit or a cloud platform. This information is then processed and analyzed to identify anomalies such as clogs, leaks, or structural damage, which could result in flooding, pollution, or safety risks.

[23] This research article focuses on the usage of Long Short-Term Memory (LSTM) networks for battery management in manhole subterranean systems. This entails placing sensors and gadgets with batteries in manholes to monitor temperature, humidity, gas levels, and structural integrity.The LSTM network is used to anticipate the battery's state of charge (SoC) and state of health (SoH) using historical sensor data. By examining data patterns and trends, the LSTM model can forecast the battery's performance and remaining capacity over time. The anticipated SoC and SoH values are utilized to optimize battery management tactics like charging times, energy harvesting, and power allocation.

[24] This research article focuses on creating a web-based manhole overflow prediction system that employs ultrasonic level sensors and an expert system. This technology is anticipated to use ultrasonic level sensors in manholes to continuously monitor water levels.The data collected by these sensors is transferred to a central server or cloud-based platform that may be accessed via the internet. The platform includes an expert system that analyzes sensor data and predicts the likelihood of manhole overflow incidents, which could be based on machine learning algorithms or rule-based reasoning.To create accurate predictions, the expert system takes into account a variety of parameters, including historical data, weather conditions, and drainage network characteristics. When the system detects a high risk of overflow, it can send alerts or notifications to appropriate stakeholders, such as municipal authorities.

[25] This research article focuses on developing a system for monitoring and managing missing manhole covers, including an alarm system for prompt detection and response. This technique most likely entails placing sensors or detectors on manhole covers around urban areas to detect their presence. When a manhole cover is missing or shifted, the sensors send an alarm, signaling a potential safety concern or infrastructure problem. This warning signal is routed to a central monitoring and management system, where it is processed and interpreted. The technology can automatically send warnings or notifications to relevant authorities, such as municipal agencies or maintenance teams, with real-time information regarding the location and status of the missing manhole cover.

[26] This research article focuses on creating an IoT-based manhole detection and monitoring system. This system is anticipated to entail the deployment of IoT-enabled sensors and devices in and around manholes to detect their presence and monitor various characteristics.Sensors may include proximity sensors, cameras, or pressure sensors to detect the presence of manhole covers and monitor parameters such as temperature, humidity, gas levels, and water

levels within the manhole. [27] This research study focuses on creating a Manhole Detection and Monitoring System with IoT Technology. This system uses sensors and devices with IoT capabilities to detect manholes and monitor various characteristics related with them. Sensors such as proximity sensors, cameras, or pressure sensors are strategically placed near manholes as part of deployment. These sensors detect the opening and closing of manhole covers while also monitoring temperature, humidity, gas levels, and water levels within the manhole.The fundamental goal of this project is to create an effective and dependable IoT-based system for identifying and monitoring manholes. This method attempts to improve urban infrastructure management and maintenance while also increasing urban safety and resilience.

[28] This research study focuses on creating a Smart Manhole Monitoring and Detection System with inexpensive single-board computers (SBCs). This technology embeds SBCs like Raspberry Pi or Arduino into manhole covers or neighboring infrastructure, resulting in a compact and efficient monitoring solution. The system uses a variety of sensors and detectors to monitor characteristics such as water levels, gas concentrations, temperature, and structural integrity inside the manhole. These sensors are coupled to SBCs, which serve as central processing units.The research intends to create a cost-effective and scalable Smart Manhole Monitoring and Detection System employing inexpensive single-board computers, which will improve urban infrastructure management and maintenance while also improving safety and resilience.

[29] This research article focuses on creating a system for detecting and removing obstructions in manhole pipes using IoT technology. This system uses sensors, actuators, and IoT-enabled devices to monitor the health of manhole pipes and respond when obstructions are discovered. Ultrasonic sensors or pressure sensors are installed inside manhole pipes to continuously monitor the flow of sewage or wastewater. These sensors detect variations in flow patterns or pressure, which can indicate the presence of an obstruction. The study's goal is to create an effective and dependable system for detecting and eliminating blockages in manhole pipes using IoT technology, which will improve urban sewage system management and maintenance while also increasing public health and safety. [30] This research study focuses on establishing an IoT-based smart drainage worker safety system to improve the safety of workers participating in drainage maintenance and operations. This system uses a variety of IoT technologies to monitor and control any dangers and risks related with drainage construction.

III. Methodology

A. System Architecture:

The given block diagram shows the Node MCU which interfaces with gas, temperature and oxygen sensors that monitors the conditions of the manhole continuously. In case of sewer workers, hazardous gasses and temperature thresholds are fed to the controller so as to enable them work in it. Safety is critical in maintaining temperatures within manholes. We should be empathetic about the heat below the surface of a manhole so as to save sewer worker’s life. If we are unkind towards this heat, then an employee may choke and eventually die. The sensor sends alert message if there are parameters above threshold level .All sensor data is stored in IOT for cloud purposes.

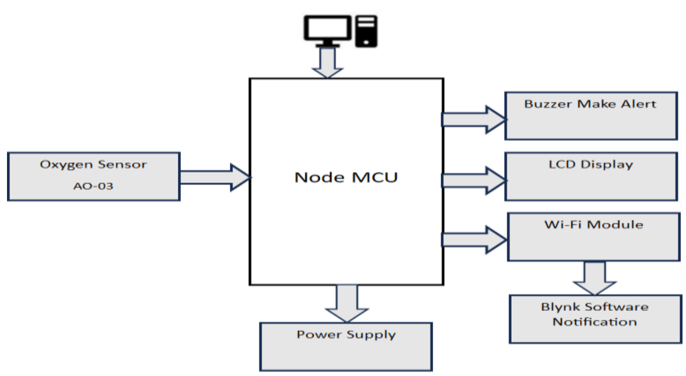

Figure 1: System Architecture

B. *Algorithm for proposed system:*

1. Add IOT sensors to maintain tabs on the drainage's level of oxygen.
2. Set up sensors round the drainage system.
3. Ascertain that the sensors are calibrated and maintained to deliver precise outcomes.
4. Install the Node MCU to processing data.
5. Start the process for gathering data.

a. Examine the oxygen sensor readings.
b. Upon processing the information gathered, establish the current values of the parameters which are being monetized.
c. To view this information presented in real time, use the Arduino IDE.
d. Evaluate the sensor data which has been processed to the present norm values.
e. An alert will sound if a parameter crosses the range that is set.
f. Archive the information gathered in the cloud for examination at a later date.
g. Repeat the loop for gathering data on a regular basis.

6. Close the tracking procedure.

C. Requirement Specification

1. NodeMCU-ESP32:

Its basis is the ESP32 the microcontroller, which combines low power consumption, Bluetooth, WiFi, and Ethernet works on a single chip. Node MCU is an open-source Internet of Things (IoT) platform founded on the Lua script programming language. Because of the NodeMCU-ESP32's breadboard-compatible design, straightforward programming using Lua script or the Arduino IDE allows for comfortable testing. As seen in the 4.2.1 figure, this board includes a Bluetooth wireless connection as well as dual-mode 2.4 GHz Wi-Fi. Node MCU's main objective is to aid programmers build Internet of Things gadgets which need wireless connectivity. It could be utilized for creating data loggers, smart home appliances, remote sensors, and other devices with internet connectivity. The ESP32 is an ar4ray of low-cost, low-power system-on-a-chip microcontrollers featuring dual-mode Bluetooth and integrated Wi-Fi.

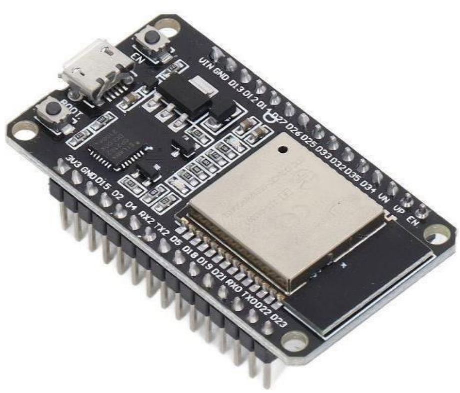

Figure 2:NodeMCU-ESP32 DEVELOPING KIT

2. Oxygen Sensor:

Oxygen sensors, frequently referred to as O2 sensors or oxygen gas detectors, serve as vital components of many different uses, including safety systems, medical equipment, and industrial settings. These sensors, that gauge the amount of oxygen in the surrounding air, provide essential information that can be used to monitor industrial processes, maintain ideal conditions, or guarantee safety.

Figure 3: OXYGEN SENSOR

3. Breadboard:

Breadboards contain a pair of power rails, frequently marked "+/-" or "VCC/GND." These rails offer a reliable means of passing electricity (such as 5V and GND) to various circuit components. The components' arrangement ensures that their leads link to the conductive metal strips inside the breadboard. It is an essential element utilised for the testing and development of electrical circuits. It offers a platform that makes it simple to construct and substitute circuits without sholdering.

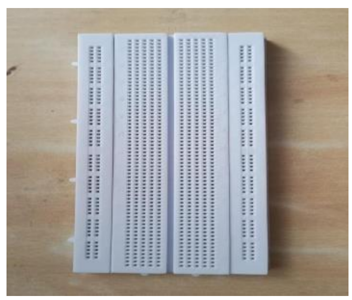

Figure 4: BREADBOARD

4. Buzzer:

A buzzer is just an aural signalling device, similar to a mechanical, piezoelectric, or electromechanical beeper. This is usually used to convert an audio signal to sound. It is commonly found in computers, printers, alarm clocks, timers, and other DC-powered equipment.

A buzzer is a simple audio device that emits sound in response to an incoming electrical signal. It is also known as a sounder, audio alarm, or audio indicator.

Figure 5: Buzzer

5. LCD Display:

An LCD (Liquid Crystal Display) is a form of flat panel display that uses liquid crystals as its main technology. LEDs are often found in computer monitors, instrument panels, televisions, cellphones, and other gadgets, thus there are many applications for both consumers and enterprises. The system's basic function in this work display is to notify travellers and pedestrians about the manhole's location, which is attached to a pole closer to the system. The LCD's basic input is linked to digital pins 2-7. People get notified when the LCD energises its data after receiving information from the main controller.

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Figure 6: LCD Display

6. Wi-Fi Module:

Wi-Fi modules are essential components that enable wireless communication in a wide range of devices, including smartphones and IoT devices. These modules, which meet IEEE 802.11 standards, allow for seamless connectivity with wireless local area networks. They come in a variety of form factors, including mini-PCIe cards, USB dongles, and chipsets, and connect to host devices using standard interfaces such as USB, UART, SPI, or SDIO. Aside from Wi-Fi, several modules include Bluetooth capabilities, providing diverse wireless communication options. Wi -Fi modules enable security protocols such as WPA2 and WPA3, ensuring data privacy and integrity while transmitting. Furthermore, manufacturers give software development kits (SDKs) to aid integration, while power -saving capabilities help optimise energy use, which is critical for battery-powered devices. Overall, Wi-Fi modules play a key role in enabling .

Fig 7:Wi-Fi Module

4. Result and Analysis

Workers in the drainage industry sometimes work in tight spaces with high risks of lack of oxygen, which is a serious safety problem. The goal of this study is to improve the safety of drainage workers by developing and implementing a real-time oxygen level sensing system. The system continually monitors and analyzes the oxygen concentrations in drainage workstations by integrating cutting-edge oxygen sensors, wireless communication technologies, and sophisticated algorithms. The system uses very sensitive oxygen sensors that are placed at strategic manholes, underground tunnels, and drainage system locations. These sensors offer real-time readings, and the data they gather is analyzed through the use of specialized algorithms that are tailored to the particular difficulties presented by the drainage industry. The algorithms account for variables that may impact accuracy, such as changing oxygen concentrations, cramped quarters, and possible pollutants.

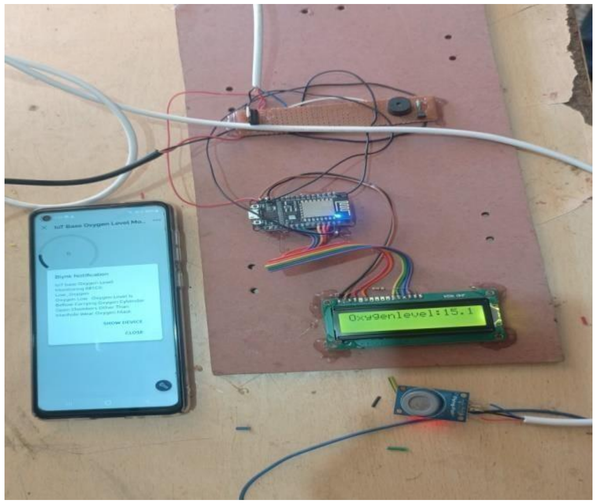

Fig.9 Sample Prototype

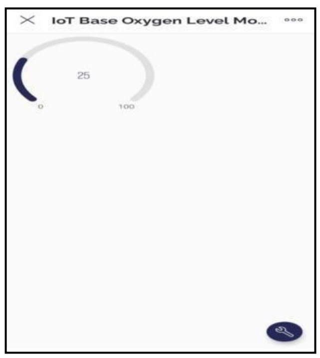

Fig.10 Screenshot of Application Developed

The following are the real time results based on experimental model

The implementation of the real-time monitoring system for oxygen, temperature, and carbon dioxide detection in manholes has yielded significant results in enhancing safety and improving efficiency in maintenance operations. Through the integration of advanced sensors and communication technology, the system has provided invaluable insights into the environmental conditions within confined spaces, enabling proactive measures to mitigate risks and prevent accidents.

One of the key outcomes of the project is the ability to monitor oxygen levels, temperature fluctuations, and carbon dioxide concentrations in real-time. By continuously tracking these parameters, maintenance personnel can promptly identify hazardous conditions and take appropriate actions to ensure their safety. The system's capability to provide timely alerts has proven instrumental in preventing accidents and minimizing the potential for injuries or fatalities during manhole operations.

Furthermore, the real-time monitoring system has facilitated better decision-making and resource allocation in maintenance activities. By accurately assessing environmental conditions within manholes, municipalities and utility providers can optimize the deployment of personnel and equipment, streamline workflow processes, and minimize downtime. Additionally, the system's data logging and analysis features enable post-incident evaluation and the refinement of safety protocols, contributing to continuous improvement in safety standards.

The analysis of the project's outcomes highlights the transformative impact of innovative technologies in addressing safety challenges associated with confined space entry. By harnessing the power of real-time monitoring and data-driven insights, this initiative has not only enhanced the safety of maintenance personnel but also improved the resilience and reliability of urban infrastructure networks. Moving forward, continued investment in such technologies is crucial to ensuring the sustainability and safety of critical infrastructure systems in urban environments.

5. Conclusion

In conclusion, the implementation of a real-time monitoring system for oxygen, temperature, and carbon dioxide detection in manholes represents a crucial step towards enhancing the safety of maintenance operations in urban infrastructure management. By addressing the current challenges associated with confined space entry, including the risks of accidents, injuries, and exposure to hazardous gases, this project aims to safeguard the well -being of maintenance personnel and ensure the uninterrupted functionality of essential utility networks. Through the integration of advanced sensors and communication technology, coupled with proactive safety measures, the proposed system offers a comprehensive solution to mitigate the inherent risks of manhole operations.

The safety system for sewage workers is crucial to the worker's survival our project help to reduce the problem of drainage worker safety, with the help of sensors like an oxygen sensor, temperature, humidity and CO2 sensor. Implementing real-time oxygen level sensors in manholes improves safety by providing workers with timely alerts about potentially hazardous conditions. This proactive strategy reduces the risk of asphyxiation and assures the safety of workers in restricted places. Furthermore, by incorporating such technologies into safety practices, firms may demonstrate their commitment to putting worker safety and regulatory compliance first. Overall, this study demonstrates the need to use technology to address major safety issues in industrial settings.

Furthermore, by providing real-time insights into environmental conditions within manholes, the monitoring system enables prompt responses to potential hazards, reducing the likelihood of accidents and improving emergency preparedness. Enhanced safety protocols, including adequate ventilation, proper lighting, and regular maintenance, are essential components of a holistic approach to ensuring the safety and efficiency of manhole operations. As urban infrastructure continues to evolve, prioritizing the safety of maintenance personnel remains paramount, and the adoption of innovative technologies such as real-time monitoring systems represents a significant stride towards achieving this goal. Through collaboration between stakeholders, including municipalities, utility providers, and technology developers, we can create safer working environments and uphold the integrity of critical infrastructure networks for the benefit of society as a whole.

6. Future Scope

Gases like CO2 and methane might be detectable in the future. To find various items in the muck, we might employ image processing. For temperature change detection, we might add a temperature sensor. To find the gases, we'll use all water-proof sensors.

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