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IoT Based Intelligent Gas Leakage Detector using Arduino

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Abstract: *This study focuses the effectiveness of the propose project Automated LPG gas leakage detector using Arduino base sensor. Specifically, it deals the main usage of the proposed project, its functionality, durability and safety and how this project works properly in other to help people as a new innovation. The project is tested out of 25 respondents that has knowledge regarding electricity, enough to understand the flow of the project its material used, functions, usage and how it works. Findings of the study revealed that the proposed project has a very good application. The proposed project has a very good application. It can detect gas primarily LPG, and other combustible gas that may cause danger to our health and my led to fire. Device has a display to show the amount of gas detected and it indicates also the percentage of or gas level being detected. In addition, on the basis of the findings of the study, it is concluded that the proposed device can be used both home and commercial establishments that it could detect early gas leakage and it will alarm so that accident can be prevented immediately. On the basis of recommendations, this device is more suitable to be used not just in individual home but also have a good usage in commercial establishments especially for food establishments where LPG usage is on daily basis. This might come handy after all the fact that it has an early detection system that will alert establishments on the gas leakage situation.*

Keywords: Gas leakage, Gas Detector, Arduino Microcontroller, IOT

I. INTRODUCTION

Natural gas was considered during the 20th century to be economically unimportant wherever gas-producing oil or gas fields were distant from gas pipelines or located in offshore locations where pipelines were not viable (Van De Ven et al., 2022). In the past this usually meant that natural gas produced was typically flared, especially since unlike oil, no viable method for natural gas storage or transport existed other than compressed gas pipelines to end users of the same gas. This meant that natural gas markets were historically entirely local, and any production had to be consumed within the local or regional network.Liquefied fossil gas is formed when fossil gas is supercooled into its liquid state at about -260 degrees Fahrenheit (-160°C), a process known as liquefaction. It is then loaded onto huge tanker ships or trucks and exported abroad, where it is returned to its gaseous state in the process of regasification. It can then be transported as fossil gas through pipelines and burned in power stations, home boilers or used in industry(Marconi & Rosa, 2023).

Developments of production processes, cryogenic storage, and transportation effectively created the tools required to commercialize natural gas into a global market which now competes with other fuels. Furthermore, the development of LNG storage also introduced a reliability in networks which was previously thought impossible. Given that storage of other fuels is relatively easily secured using simple tanks, a supply for several months could be kept in storage(Wang & Azam, 2024). With the advent of large-scale cryogenic storage, it became possible to create long term gas storage reserves. These reserves of liquefied gas could be deployed at a moment's notice through regasification.Liquefied petroleum gas, is one of the most common alternative fuels used in the world today. In fact, in many places, it isn't an alternative fuel at all. It is a mainstay for heating and cooking in all areas. Liquefied Petroleum Gas (LPG) is a by-product of natural gas extraction and crude oil refining(Raslavičius et al., 2014). LPG is a mixture of hydrocarbon gases, the most common being butane and propane. At room temperature, LPG is a colorless and odorless non-toxic gas. Under modest pressure or cooler conditions, it transforms into a liquid state.LPG may leak as a gas or a liquid. If the liquid leaks it will quickly evaporate and form a relatively large cloud of gas which will drop to the ground, as it is

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heavier than air. LPG vapors can run for long distances along the ground and can collect in drains or basements. When the gas meets a source of ignition it can burn or explode(Jia et al., 2021).Gas leak detection is the process of identifying potentially hazardous gas leaks by sensors. These sensors usually employ an audible alarm to alert people when a dangerous gas has been detected. Exposure to toxic gases can also occur in operations such as painting, fumigation, fuel filling, construction, excavation of contaminated soils, landfill operations, entering confined spaces, etc(Proceedings & 2020, 2020). Common sensors include combustible gas sensors, photoionization detectors, infrared point sensors, ultrasonic sensors, electrochemical gas sensors, and semiconductor sensors. All of these sensors are used for a wide range of applications and can be found in industrial plants, refineries, waste-water treatment facilities, vehicles, indoor air quality testing and homes(Thangamani et al., 2021).

The aim of this project is to monitor the gas leakage in order to prevent any hazards that LPG gas may bring. It is much safer to think that a quality device that can detect gas leakage are installed in such way that it can help to eliminate vulnerabilities in gas exposure. With all intents and purpose, the researchers are enthused to pursue a research project that will develop something unconventional, useful, and affordable device with a practical purpose.

II. REVIEW OF LITERATURE

Gas leak detection is the process of identifying potentially hazardous gas leaks by sensors. These sensors usually employ an audible alarm to alert people when a dangerous gas has been detected. Exposure to toxic gases can also occur in operations such as painting, fumigation, fuel filling, construction, excavation of contaminated soils, landfill operations, entering confined spaces(Evalina & A Azis, 2020).

GAS LEAKAGE DETECTOR

A gas detector is a device that detects the presence of gases in an area, often as part of a safety system. This type of equipment is used to detect a gas leak or other emissions and can interface with a control system so a process can be automatically shut down(Hasibuan et al., n.d.). A gas detector can sound an alarm to operators in the area where the leak is occurring, giving them the opportunity to leave. This type of device is important because there are many gases that can be harmful to organic life, such as humans or animals. Gas detectors can be used to detect combustible, flammable and toxic gases, and oxygen depletion. This type of device is used widely in industry and can be found in locations, such as on oil rigs, to monitor manufacture processes and emerging technologies such as photovoltaic(Nahid et al., n.d.).

ARDUINO BASE SENSOR

Arduino board designs use a variety of microprocessors and controllers. The boards are equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards or breadboards (*shields*) and other circuits. The boards feature serial communications interfaces, including Universal Serial Bus (USB) on some models, which are also used for loading programs from personal computers(Mariselvam & Dharshini, 2020). The microcontrollers are typically programmed using a dialect of features from the programming languages C and C++.

In addition to using traditional compiler tool chains, the Arduino project provides an integrated development environment (IDE) based on the Processing language project.This gas leakage detection project based on Arduino UNO.

The low-cost project uses MQ6 gas sensor which can be calibrated to detect leakage levels based on surroundings. The installation generates a sound alert using buzzer on detection of a dangerous leakage(Taiwo et al., n.d.). The project utilizes the 434 MHz RF module so the alarm can be installed anywhere within the building and even multiple alarms can be installed within a building(Jones & Chen, 2020).The MQ6 gas sensor detects concentration of gas in ppm and outputs analog value which can be converted to digital measure using in-built Analog to Digital Convertor of Arduino. The value of the digital measure will be 10-bit long and varies from 0 to 1023(Syeda Bushra Shahewaz & Ch. Rajendra Prasad, 2020). The project allows user to set the dangerous level for leakage based on the same digital measure. When the value set by the user matches with that of the value detected by the sensor, it invokes the alarm. The MQ6 sensor can be calibrated by interfacing a load resistance of fixed value with the sensor.

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III. CONCEPTUAL FRAMEWORK

Material inputs in innovating the device is carefully planned, designed, constructed, tested and evaluated in order to achieve efficiency of the innovation.

Figure 1: Conceptual Model of the Study

Figure 1 shows the study's conceptual framework. The study's flow is depicted in the figure. First box represents the input of the study. This entails the first step in developing all the concepts in order to materialized the project. It also implicates on how the proposed project being weighed. The second box entails the designing and fabrication of the project. This area discusses the whole design of the project, its diagram and the connection point. Base on the materials gathered fabrication stage will follow by following the procedural design of the project.

In order to get the desired product, project prototyping demands a great deal of attention, which can spark ideas. The collecting of tools and resources is a vital step in creating projects, according to Atkins (2014). In completing the project, it is the most important component. The third box complies the output of the device. It is understood that in this stage the device is now on its completion and undergo already series of testing.

Objectives of the Study

The main objective of the study is to produce an automated LPG gas leakage detector using Arduino base sensor device. Specifically, the study aims to:

- helps to detect LPG gas leakage to prevent any accident to happen.
- design and develop automated LPG gas leakage detector device;
- formulate comprehensible user's manual of the device; and
- conduct cost benefit analysis.

Significance of the Study

This research project shall be valuable to the following individuals:

- **Households and Establishments.** Enable them to be safe upon using automated LPG gas leakage detector device and prevent any untoward incident.
- **Industrial Entities.** The study may provide quality outputs that shall boost the aim of innovation and effective technology transfer.
- **Future Researchers.** The prototype may be the bases of the other researchers for future conduct of project studies in improving grounded on lapses found the present study.

Scope and Limitations

The main focus of the study is to produce an automated LPG gas leakage detector device to be use in households, and establishments. The production of this kind of project should not limit in Surigao City but also in other provinces and in the country. The conduct of the project will be made by the researchers with the aid of relevant knowledgeable people. However, innovative ideas of the researchers shall still be followed.

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Definition of Terms

- **Gas Detector.** Is a device that detects the presence of gases in an area, often as part of a safety system.
- **Device.** In the study, it defined as the proposed prototype which is automated LPG gas leakage detector device
- **Prototype.** Something thatservestoillustratethetypicalqualitiesofaclass;model;exemplar.
- **Operation.** It is defined as an act or instance, process, or manner of functioning or operating.

Project Design

Below is the architectural design of the research device (power interrupter control device), included the labeled parts of the research project.

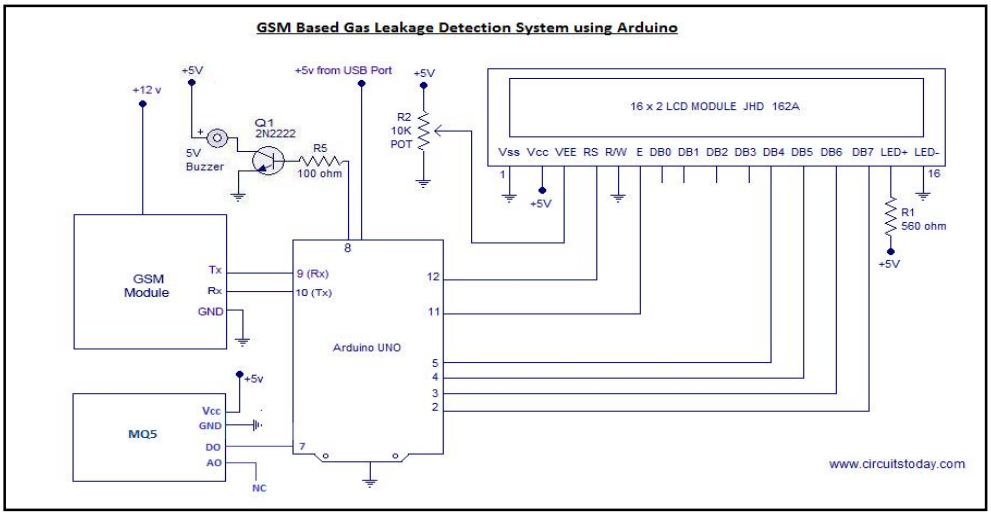

Figure 2: Schgematic Diagram

Project Development

The following are procedural steps in making the project.

- Gather all necessary material needed in making the said project.
- Check and make sure that all the devices to be use is functional and not defective.
- Connect all the necessary parts that are needed.
- Check all the components if it is exactly connected
- Test the components if it is functioning will.
- After setting all the components, checking the proper connections, testing the prototype will commence.

Operation Procedure

In determining the performance of the device, the following procedure was followed:

- Check the whole system whether all the components are correctly installed.
- Inspect connections that would possibly make up accidents.
- Prepare the required materials for the conduct of operation
- Observe proper or correct installation.

Testing Procedure

In order to assure that every part of the device is working properly, the following test procedure should be done:

- Check every part of the device.
- Testing the functionality of every parts.
- Check each connection points.

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- Set the time for estimated desired timing function.
- Test the device and conduct an assessment and efficiency on it.

IV. EVALUATION PROCEDURES

Evaluation is a way to determine the acceptability of the proposed project. Selected people were asked to rate the performance of the device. These respondents were composed of selected residents in Surigao City who have specialized on the field. Prior to the actual demonstration/evaluation of the device, the researcher explained the function of the device as well as its specification of the prototype. Before the evaluation sheet was given to the respondents, its content was discussed by the researchers. When the evaluation has been accomplished, the result was tabulated and computed to find the mean of every criterion as well as the overall mean.The respondents will then evaluate the said proposed project based on usability, quality of design, functionality, safety, and efficiency. The evaluation sheet is provided where respondents can write their comments and suggestions for further improvement of the device.

V. RESULTS AND DISCUSSIONS

Evaluation result of the study is based on the instruments made by the researchers. Each variable in the instruments reflect on the project that caters the process of propose project.

Acceptability of Gas Leakage Detector System based on its Functionality

Criteria and Statement	Mean	Qualitative Description
A. Functionality		
Function of the device is meet as it expected.	4.45	**Excellent**
The device performs the task effectively.	4.35	**Excellent**
The device has a minimal error.	4.05	Very Good
The device can be enhanced or updated.	3.75	Very Good

4.21 – 5.00	Excellent
3.41 – 4.20	Very Good
2.61 – 3.40	Good
1.81 – 2.60	Fair
1.00 – 1.80	Poor

The table uses four distinct statements about the functionality and performance of a gadget to evaluate the "Functionality" criterion. Each claim outlines a unique feature of the device's operation. The average ratings or scores assigned to each statement are shown in the "Mean" column. As an illustration, Statement 1 scored on average 4.45, Statement 2 scored on average 4.35, and so on. The overall evaluation of each statement's functionality is reflected in the mean score. Based on each statement's mean score, the "Qualitative Description" column offers a qualitative evaluation or description of it. Statements 1 and 2 in this instance were given the rating of "Excellent," signifying that they were highly regarded and delivered great work. Statement 3 was given the rating "Very Good," indicating that it performed admirably but could have been improved slightly. Also given the rating of "Very Good," Statement 4 performed admirably but might use some improvements or upgrades. This table suggests that the functionality of the gadget was positively assessed. The device was given a "Excellent" grade for statements 1 and 2, which refer to the equipment meeting expectations and carrying out duties efficiently. Statement 3 was given the grade "Very Good," which denotes strong performance with little room for improvement. It tackles faults that are quite small. Similar to Statement 4, which received a "Very Good" rating, it is possible to increase the device's functioning by updating or improving it.

Acceptability of Gas Leakage Detector System based on its Applicability

The table displays the respondents' perceptions, which assess the "Applicability" criterion based on three distinct assertions about how well-suited and adaptable the device is to various applications and user requirements. The average ratings or scores assigned to each statement are shown in the "Mean" column. As an illustration, Statement 1 obtained

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an average score of 4.15, Statement 2 an average score of 4.20, and Statement 3 an average score of 4.35. The total evaluation of the applicability of each statement is represented by the mean score.

B. Applicability	Mean	Qualitative Description
The device has a specific application	4.15	Very Good
The device accommodates the specific needs of its users.	4.20	Very Good
The device meets the safety standards.	4.35	**Excellent**

Based on each statement's mean score, the "Qualitative Description" column offers a qualitative evaluation or description of it. Statements 1 and 2 in this situation were both given the rating "Very Good," meaning that they were highly regarded and thought to have good application. However, Statement 3 was given the rating of "Excellent," indicating that it was extraordinary and met or surpassed safety requirements.This table suggests that the device's applicability was given a favorable evaluation. According to Statement 1, the item has a specified application, and it was given a "Very Good" rating, indicating that it is suitable for a specific function or purpose. Statement 2 emphasizes the device's ability to accommodate certain user needs. It also received a "Very Good" grade, signifying that it is able to satisfy the wants and preferences of its users. The device's commitment to safety standards is highlighted in Statement 3 and is given a "Excellent" rating, demonstrating that it not only satisfies but also exceeds the set safety requirements.

Acceptability of Gas Leakage Detector System based on its Workability

C. Workability	Mean	Qualitative Description
Availability of materials	4.25	**Excellent**
Availability of expertise	4.10	Very Good
Availability of tools and machines for fabricating	4.00	Very Good

Based on three particular claims about the availability of materials, knowledge, and equipment and machines for fabrication, the table assesses the "Workability" criterion. The average ratings or scores assigned to each statement are shown in the "Mean" column. As an illustration, Statement 1 received a mean score of 4.25, whereas Statements 2 and 3 both obtained a mean score of 4.10. The total evaluation of the viability of each assertion is reflected in the mean score. Each statement is given a qualitative evaluation or description in the "Qualitative Description" column based on its mean score. In this instance, Statement 1 was given the designation of "Excellent," suggesting that it was given an exceptional rating and was thought to have excellent material availability. Both Statements 2 and 3 were evaluated as "Very Good," indicating that they were highly regarded but had space for development.This table suggests that the device's use was assessed favorably, albeit there were considerable differences across the comments. The material accessibility statement (statement 1), which focuses on the materials' accessibility, obtained a "Excellent" rating, indicating that the materials' accessibility met or surpassed expectations. A "Very Good" rating was given to Statement 2 about the availability of expertise, indicating that while it was available, there may be some room for improvement or greater availability. A "Very Good" grade was also given to Statement 3, which deals with the accessibility of tools and equipment for fabrication. This rating suggests that, despite the good accessibility, there may be opportunity for development or growth.

Acceptability of Gas Leakage Detector System based on its Durability

D. Durability	Mean	Qualitative Description
Resistance for deformation	4.15	Very Good
Quality of the design	4.45	**Excellent**
Endurance of the unit to high temperature	4.05	Very Good

The table evaluates the "durability" criterion based on three distinct statements about the unit's ability to withstand high temperatures, resist deformation, and be well-designed. The average ratings or scores assigned to each statement are shown in the "Mean" column. As an illustration, Statement 1 obtained an average score of 4.15, Statement 2 an average score of 4.45, and Statement 3 an average score of 4.05. The durability of each assertion is evaluated overall and represented by the mean score. Each statement is given a qualitative evaluation or description in the "Qualitative Description" column based on its mean score. In this instance, Statements 1 and 3 were both given the rating of "Very

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Good," indicating that they were highly regarded and thought to have good longevity. Statement 2 was given the rating of "Excellent," signifying that its design was of the highest caliber and that it was extraordinarily well regarded.The device's durability was determined to be favorable based on the information in this table. Statement 1, which focuses on deformation resistance, was given a "Very Good" rating, indicating that the device demonstrated good resilience and kept its form under a variety of circumstances. A "Excellent" rating was given to Statement 2, indicating that the device's design was of the highest caliber, which is essential for durability. According to statement 3's "Very Good" grade, the gadget showed good durability even in high-temperature situations. This statement deals with the unit's resistance to high temperatures.

Acceptability of Gas Leakage Detector System based on its Safety

E. Safety	Mean	Qualitative Description
Absence of sharp edges	4.15	Very Good
Absence of toxic materials	4.10	Very Good
Provision for protection	4.10	Very Good

The absence of sharp edges, the absence of poisonous compounds, and the provision for protection are three specific assertions that the table uses to evaluate the "Safety" criterion. Mean: Each statement's average score or rating is shown in the "Mean" column. As an illustration, Statement 1 obtained an average score of 4.15, Statement 2 an average score of 4.10, and Statement 3 an average score of 4.10. The overall evaluation of each statement's safety is represented by the mean score. Qualitative Description: Each statement is given a qualitative evaluation or description based on its mean score in the "Qualitative Description" column. All three of the statements in this instance were given the rating "Very Good," indicating that they were highly regarded and thought to have good safety precautions.The device's safety was determined to be satisfactory based on the information in this table. Statement 1, which focuses on the lack of sharp edges, obtained a "Very Good" rating, meaning that the item was created without sharp edges that could possibly cause damage or injury. The item was free of dangerous or harmful materials that might endanger users, according to Statement 2, which similarly obtained a "Very Good" rating. The equipment appeared to have adequate safeguards in place to shield users from potential risks, as evidenced by Statement 3's "Very Good" assessment, which addressed the provision for protection.

Overall Acceptability

Criteria	**Mean**	**Rank**	**Qualitative Description**
A. Functionality	4.15	**3**	Very Good
B. Applicability	4.23	**1**	**Excellent**
C. Workability	4.11	**5**	Very Good
D. Durability	4.22	**2**	Very Good
E. Safety	4.12	**4**	Very Good
Grand Mean	4.17		Very Good

The table shows how well an Arduino-based doorbell meets a variety of criteria based on mean scores, rankings, and qualitative descriptions. Five different criteria—Functionality, Applicability, Workability, Durability, and Safety—are listed in the table. These standards most likely represent various features or traits that are being assessed for acceptability. The average ratings or scores assigned to each criterion are shown in the "Mean" column. For instance, the mean score for functionality was 4.15, the average for applicability was 4.23, and so on. The entire evaluation or assessment of each criterion is reflected in the mean score.The ranking of each criterion according to its mean score is shown in the "Rank" column. Applicability had the highest rank (1) in this instance, indicating that it had the greatest mean score of all the criteria. Safety obtained the third rating, Durability the second position, and so on. Based on each criterion's rank, the "Qualitative Description" column offers a qualitative evaluation or description of it. In this table, every criterion was given the rating "Very Good," indicating that it performed admirably and complied with all specifications. The "Grand Mean" is the sum of all mean scores. In this instance, the Grand Mean is calculated as 4.17,

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reflecting an overall evaluation of "Very Good" for the overall acceptability.It can be deduced from the presented table that the evaluated categories, including Functionality, Applicability, Workability, Durability, and Safety, were rated as "Very Good" in terms of their acceptability. The top ranking went to Applicability, with Durability and Safety coming in at numbers two and three, respectively. Overall, this table implies that the acceptability-based criteria were highly scored and performed well, indicating a favorable overall evaluation.

VI. SUMMARY

This study focuses the effectiveness of the propose project Automated LPG gas leakage detector using Arduino base sensor. Specifically, it deals the main usage of the proposed project, its functionality, durability and safety and how this project works properly in other to help people as a new innovation. The project is tested out of 25 respondents that has knowledge regarding electricity, enough to understand the flow of the project its material used, functions, usage and how it works.

VII. FINDINGS

The findings of the proposed project are listed below:

1. The proposed project has a very good application.
2. It can detect gas primarily LPG, and other combustible gas that may cause danger to our health and my led to fire.
3. Device has a display to show the amount of gas detected and it indicates also the percentage of or gas level being detected.

VIII. CONCLUSION

The following conclusions are drawn based on the findings of the study.

1. Both Home and Establishment must use the propose device in order to protect them from combustible gases.
2. The device could detect harmful gases ad it will signal immediately.
3. This device also can prevent from inhaling combustible gases that could also to cause fire.

IX. RECOMMENDATIONS

1. Home and establishment owners: This device has a very important usage in detecting LPG leakage at home and other commercial establishment.
2. Future Researchers. They are encouraged to conduct studies similar to the present investigation in their domain school.

REFERENCES

[1] Evalina, N., & A Azis, H. (2020). Implementation and design gas leakage detection system using ATMega8 microcontroller. *IOP Conference Series: Materials Science and Engineering*, *821*(1).

[2] Hasibuan, M., Series, I. I.-J. of P. C., & 2019, undefined. (n.d.). Intelligent LPG gas leak detection tool with SMS notification. *Iopscience.Iop.Org*.

[3] Jia, Q., Fu, G., Xie, X., Hu, S., Wu, Y., & Li, J. (2021). LPG leakage and explosion accident analysis based on a new SAA method. *Journal of Loss Prevention in the Process Industries*, *71*.

[4] Jones, C. G., & Chen, C. (2020). An arduino-based sensor to measure transendothelial electrical resistance. *Sensors and Actuators, A: Physical*, *314*. https://doi.org/10.1016/j.sna.2020.112216

[5] Marconi, P., & Rosa, L. (2023). Role of biomethane to offset natural gas. *Renewable and Sustainable Energy Reviews*,

[6] Mariselvam, V., & Dharshini, M. S. (2020). IoT based level detection of gas for booking management using integrated sensor. *Materials Today: Proceedings*, *37*(Part 2), 789–792.

[7] Nahid, S., Anjum, N., … N. C.-2021 I. 12th, & 2021, undefined. (n.d.). Development of a Smart Automatic Gas Leakage Detector and Alarming System. *Ieeexplore.Ieee.Org*. Retrieved April 6, 2022,

[8] Raslavičius, L., Keršys, A., Mockus, S., Keršiene, N., & Starevičius, M. (2014). Liquefied petroleum gas (LPG) as a medium-term option in the transition to sustainable fuels and transport.

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[9] Syeda Bushra Shahewaz, & Ch. Rajendra Prasad. (2020). Gas leakage detection and alerting system using Arduino Uno. *Global Journal of Engineering and Technology Advances*, *5*(3), 029–035.

[10] Taiwo, A., Femi, O., Ruth, A., Telkomnika, P. O.-, & 2022, undefined. (n.d.). Determination of optimum load resistances of MQ-series gas sensor circuit for specific gas concentrations. *Search.Ebscohost.Com*.

[11] Thangamani, G. J., Deshmukh, K., Nambiraj, N. A., & Pasha, S. K. K. (2021). Chemiresistive gas sensors based on vanadium pentoxide reinforced polyvinyl alcohol/polypyrrole blend nanocomposites for room temperature LPG sensing. *Synthetic Metals*, *273*.

[12] Van De Ven, C. J. C., Laurenzi, L., Arnold, A. C., Hallam, S. J., & Mayer, K. U. (2022). The nature of gas production patterns associated with methanol degradation in natural aquifer sediments: A microcosm study. *Journal of Contaminant Hydrology*, *247*

[13] Wang, J., & Azam, W. (2024). Natural resource scarcity, fossil fuel energy consumption, and total greenhouse gas emissions in top emitting countries. *Geoscience Frontiers*, *15*(2), 101757.