INVENTION DISCLOSURE FORM

Applicant Name- BML Munjal University
Applicant Address- 67th Milestone, NH 48, Kapriwas, Haryana 122413,
T: (+91) 124 2679002, Email: info@bmu.edu.in

1. Particulars of Inventors

Mr./Ms	Name (Full)	Department	Designation	Mobile No.	Email	Postal Address
Mrs.	Nihar Singla	CSE, SOET	Student	9817157589	Nihar.singla.22cse@bmu.edu.in	447/27 DLF colony Rohtak (Haryana) 124001
Mr.	Piyush Garg	CSE, SOET	Student	9996361794	Piyush.garg.22cse@bmu.edu.in	640 A/35 Janta Colony Rohtak (Haryana) 124001
Mr.	Manan Khandelwal	CSE, SOET	Student	7728006511	Manan.khandelwal.22cse@bmu.edu.in	22/52 Usri gate Near police chowki Ajmer (Raj.) 305001
Mr.	Bhavesh Choudhary	CSE, SOET	Student	8078630832	Bhavesh.choudhary.22cse@bmu.edu.in	Flat no. 902 tower 8 Rangoli Greens Vaisali Nagar, Jaipur (Raj.) 302001
Mr.	Divyanshu Bansal	CSE, SOET	Student	8824699563	Divyanshu.bansal.22cse@bmu.edu.in	822 Mahaveer Nagar First Kota (Raj.) 324005

2. Provide a brief descriptive title of the invention:

IoT-Enabled Smart Safety Helmet for Hazard Detection and Worker Protection

3. **In 100 words or less, please provide an abstract or summary of the invention:**

Smart Safety Helmet is a proposed wearable technology applicable for the industrial workers and miners. It embraces the features like gas detectors, temperature sensors, fall detection, and light sensors to track the user and his/her environment's status online. When the conditions that are dangerous for the wearer; like the levels of the specific gases, temperature or a fall, it beeps and activates the LED light. The system also fosters a worker safety notification system that alerts workers and employers about possible danger so as to deal with the difficulties as soon as possible, in order to help with safety management and reduce dangers in dangerous industrial regions and mining jobs.

4. **Detail description of the invention:**

   a. **Problem the invention is solving**

In particular, conditions of industrial and mining facilities include different dangerous factors, for example toxic gases leak, temperature variations, and falls which often result in severe injuries or

fatalities. Despite their usefulness, most conventional protective gear does not have the capacity for continuous surveillance and fail to give an early warning once hazardous circumstances are present. Further, there would be no facilities to identify falls or a proper way of signalling for an emergency. These obstacles characteristic the difficulties of current smart safety helmet since it incorporates continuous environment and health tracking to give genuine-time responses to avoid mishaps.

   b. **General Utility/application of the invention**

This particular product targeted the risky sectors for instance mining area; construction companies and factories. They can be employed where workers are likely to be exposed to toxic fumes, hot or cold environments or likely to fall off. This helmet ensures worker safety by:

- Detecting toxic gases like carbon monoxide and methane.
- Monitoring the ambient temperature to prevent heat stress.
- Detecting falls and alerting supervisors or co-workers.
- Ensuring visibility in low-light conditions via the integrated light sensor. The helmet may also be fitted for use in other fields such as oil and gas, chemical manufacturing plants, and especially in warehouses where workers require vigilance regarding their safety and the state of environment around them.

c. Advantages of the invention disclosing about the increased efficiency/efficacy

The Smart Safety Helmet provides several advantages over traditional safety equipment:

- Real-time Monitoring: The helmet constantly monitors other critical environmental parameters such as gases, temperature, and the movement of the wearer and sounds an alarm when danger is imminent.
- Multi-Sensor Integration: Because there is gas detection, temperature check, fall detection and even light sensors all integrated in the helmet, the probability of needing other additional devices is minimized.
- Proactive Hazard Detection: Audible and visual signals are given when the risk factors are present, and this means that the employee can be immediately informed of developmental hazards and thus can work faster and avoid accidents.
- Durability and Comfort: Meant to be used throughout multiple shifts, every sensor and component can be incorporated into the headgear without adversely affecting the worker's comfort or constraining his or her movements.
- Automatic Safety Features: Some of the safety features, for example, the fan, can be set to go on by itself where there is presence of toxic gases or extreme heat thereby less dependency on the worker to turn it on.
- Wireless Communication (Optional): With internet integration it can send status information to a remote monitoring station or other cloud host, which in the case of workplace safety removes the supervisor from having to go into dangerous areas of the work area.

d. Best way of using the invention as well as possible variants

The Smart Safety Helmet should be worn in any situation where there are potentially lethal gases, hot temperatures or circumstances where there is a risk of falling. There were also systems within the helmet that will be checking the condition of the worker as well as the conditions in the environment. If any of these thresholds is tripped, the helmet will provide the user feedback through visible and audible signals, although there could be an additional connectivity to a central monitoring station for other action.
Possible Variants:

- Enhanced Communication: Optional equipment is the possibility of installation of the Bluetooth/Wi-Fi communication system that will enable the workers and supervisors to communicate directly with teammates.
- Extended Battery Life: Future models may have those features like the solar panel installation or energy-harvesting abilities to help to prolong battery power in the desert.

- Advanced Sensors: Extra types of sensors as radiation sensors or dust sensors are also possible to install to have more specific objectives.
- Augmented Reality (AR): A modification of the helmet could include augmented reality in displaying important safety information or guidelines right in the user's vision range.

e. Working of invention along with Drawing, schematics and flow diagrams if required with complete explanations.

The Smart Safety Helmet is made up of the following parts through which the entire process of worker safety is facilitated.

- Gas Sensors: The MQ-2 gas sensor is able to measure dangerous gases, such as methane, carbon monoxide and LPG found in homes. When the gas density departs from a certain point, the gas alarm of the helmet is activated, lighting the LED and powering on the fan to ventilate the zone and notify the worker.
- Temperature Sensor (DHT11): The DHT11 is used to measure room temperature. If the temperature goes beyond the said range (May be 60° C), then the helmet starts flashing to notify the worker of heat stress.
- Fall Detection (MPU6050): The built-in accelerometer, MPU6050 detects the motion of the device, tilts, falls, etc. When the worker falls, the helmet turns on an LED light and buzzer to indicate an emergency situation.
- Light Sensor (LDR): The LDR is able to detect low light conditions. In the event that the ambient light is low, the headlamp is activated so that the worker is seen and everything he or she is working on is well illuminated.
- Fan: It is used when a dangerous concentration of the gas or high temperature is present for a worker and helps to ventilate the area.
- Power Supply: This helmet is empowered with a lithium-ion battery charge that is incorporated within a Battery Management System (BMS) for safety. An exclusive feature is an optional solar panel for maintaining a constant power supply to the equipment in regions that may be off the grid.
- Microcontroller (ESP32): ESP32 in this project serves as a microcontroller to input data from all the sensors, control the LEDs, buzzer, and fan and to have the communication interface(s) if IoT is implemented. Hazard information from the ESP32 can be transmitted to a monitoring station in real-time depending on the choice of either Wi-Fi or Bluetooth connectivity.

Flow Diagram for Working: [include below]
Sensors Continuously Monitor:

- Gas levels, temperature, movement, and light conditions are continuously monitored.

Threshold Exceeded:

- If any threshold is exceeded (e.g., high gas level, temperature, or a fall), the corresponding alert system is triggered (LED + Buzzer).

Safety Measures Activated:

- The fan is activated if gas or temperature exceeds the threshold, and the light sensor turns on the headlamp in low light.

Data Transmission (Optional):

- Data is sent to a central monitoring station or cloud platform for further analysis or alerting supervisors.

This description outlines the Smart Safety Helmet's functionality, its working components, and how it ensures worker safety in hazardous environments by monitoring gas levels, temperature, falls, and light conditions in real-time.

5. **Have you conducted Primary Patent Search? Yes / No (if yes, attach the patent search report)**

No, we have not conducted a primary patent search for this invention yet. The focus so far has been on the development, testing, and refinement of the Smart Safety Helmet, ensuring its functionality and real-time monitoring capabilities for miners and industrial workers. As the next step, conducting a detailed patent search will be essential to identify any existing similar technologies, ensure novelty, and refine the invention further if required. This process will help us understand the prior art and confirm the uniqueness of our design before proceeding with the patent filing.

6. **Existing state-of-the-art and prior arts: (Brief background of the existing knowledge/product/process in the market)**

1. Traditional Safety Helmets:

Current Market Products:

- Basic helmets designed to protect against physical injuries.
- Do not include sensors for environmental monitoring or real-time alerts.

Limitations:

- Lack of real-time detection of hazardous gases, extreme temperatures, or falls.
- No automatic alerts or communication capabilities.

2. Smart Helmets with Limited Features:

IoT-Enabled Helmets:

- Some products incorporate basic IoT features for monitoring environmental conditions (e.g., gas levels, temperature).

- Few helmets include fall detection but rely on rudimentary accelerometer-based systems with high false positives.

Examples:

- Smart helmets with integrated gas sensors used in chemical industries.
- Construction helmets with headlamps and basic alerts for low light.

3. Wearable Safety Systems:

Available Technologies:

- Wearable devices like smart bands monitor worker vitals (e.g., heart rate, oxygen levels).
- Devices for detecting harmful gases in mining areas.

Gaps:

- These systems are often standalone devices, not integrated into a single, wearable solution like a helmet.
- Workers need to carry multiple devices, increasing the chance of device loss or neglect.

4. Limitations of Existing Solutions:

Fragmented Systems:

- Current products target specific hazards (gas or heat) without offering a unified solution.
- No Real-Time Alerts:
- Delayed notifications or manual monitoring reduce effectiveness in emergencies.

Poor Integration:

- Lack of integration of fall detection, gas monitoring, and temperature sensing in a single, durable, wearable device.

Innovation of Our Solution

The Smart Safety Helmet fills these gaps by combining all the essential monitoring necessities of an industrial worker or a miner into one IoT device, with active protection systems against toxic gases, high temperature, falling, or operating in low light environments. This helps prevent real-time hazards identification, timely warning and enhanced management of safety.

7. **List out the known ways about how others have tried to solve the same or similar problems? Indicate the disadvantages of these approaches. In addition, please identify any prior art documentation or other material that explains or provides examples of such prior art efforts.**

S. No.	Existing state of art	Drawbacks in existing state of art	Overcome (how your invention is overcoming the drawback)
1	Basic Safety Helmets	No environmental monitoring or real-time alerts.	Integrates gas, temperature, fall, and light detection sensors.
2	Gas Detectors	Handheld; not wearable or integrated into helmets.	Embeds gas detection directly into a wearable helmet design.
3	Standalone Fall Detectors (e.g., smart bands)	High false positives, separate device; not integrated with helmets.	Accurate fall detection using MPU6050 integrated into the helmet.
4	IoT-Enabled Helmets with Limited Features	Covers specific hazards only (e.g., gas or temperature).	Unified solution covering multiple hazards in one wearable device.
5	Manual Worker Monitoring Systems	Requires constant manual supervision, delayed response times.	Real-time automatic alerts and notifications via IoT integration.
6	Helmets with Only Physical Protection	Provides no hazard detection or worker monitoring.	Offers environmental and health monitoring with real-time feedback.

8. List the Technical features and Elements of the invention along with the Description of your invention from start to end.

1. Gas Detection System (MQ-2 Sensor)

Feature: Not only for detecting gases such as methane, LPG, carbon monoxide as well as smoke.
Working: The sensor is always on to detect fluctuating gaseous concentration within the immediate vicinity. If the concentration goes beyond a predefined limit, an LED light emitted to avail the information and most importantly, the fan is switched on for air circulation.

2. Temperature control module (Digital Temperature Sensor DHT11)

Feature: Records air temperature to make sure that the worker is not working under high temperature.
Working: The sensor also has an ability of real time temperature measurement. In our proposed method, if the temperature goes high, say above 60 °C, an LED lamp is turned on to alarm the worker.

3. Fall Detection System (MPU6050 Sensor)

Feature: For falls or sudden movements, the smart shirt uses an accelerometer and a gyroscope.
Working: It actively tracks the motion of the worker throughout the work process. When acceleration falls out of a predetermined range (signifying free fall) and an impact is sensed, both the fall detection LED and the buzzer are activated.

4. The LDR Sensor also known as light detection system.

Feature: The electrons also convert automatically to black or low light when the helmet light is turned on in low-light conditions.
Working: Measures the extent of illumination in the surrounding and activates the LED headlamp when the environment is dimly illuminated.

5. Alert and Notification System

Feature: Aids with signals in risky situations via the Light Emitting Diodes and a buzzer.
Working:

- Gas detection turns on the gas LED and the fan.
- High temperature turns on temperature LED.
- Fall detection leads to illumination of a fall LED and sounding of a buzzer.

6. Alert and Notification System

Feature: Uses LEDs and a buzzer to provide visual and auditory alerts in hazardous conditions.
Working:

- Gas detection activates gas LED and fan.
- High temperature activates temperature LED.
- Fall detection activates fall LED and buzzer.

7. Power System

Feature: Lithium-ion battery self-charging is employed to charge the helmet's battery.
Working: Equipped with a battery that has a Battery Management System (BMS) that sends a safer method of charging along with the most efficient use of energy. It can also be plus, because some solar panels may cost extra, which can add to the life span of the battery.

8. Microcontroller (ESP32)

Feature: Acts as the central processing unit, controlling all sensors and components.
Working:

- Continuously reads sensor data.
- Activates alarms when thresholds are exceeded.
- Sends data to a remote monitoring system (optional via IoT).

9. IoT Integration (Optional)

Feature: Enables remote monitoring and notification via a web database or through the WhatsApp application.

Working: Information retrieved from the sensors can be relayed to supervisors or to contacts in case of an emergency.

Description of the Invention (From Start to End)

Initialization:

- The helmet powers on, and the ESP32 initializes all connected sensors (MQ-2, DHT11, MPU6050, and LDR).

Real-Time Monitoring:

- Sensors continuously collect environmental data (gas levels, temperature, motion, and light).

Hazard Detection and Alerts:

- If hazardous gas levels or high temperatures are detected, the system activates visual (LED) and auditory (buzzer) alerts.
- The fall detection system identifies free falls or impacts and triggers emergency alerts.

Proactive Safety Measures:

- The helmet automatically activates a fan for ventilation during high gas levels.
- The headlamp turns on in low-light conditions.

Notification System:

- Alerts are sent to the worker via LEDs and a buzzer.
- Optional IoT integration allows data transmission to a remote system for supervisors to take action.

Power Management:

The helmet uses a rechargeable battery with a BMS to ensure long-lasting performance and safety.

9. List out the features of your invention which are believed to be new and distinguish them over the closest technology.

Feature	What's New	How It Differs from Closest Technology
Integrated Gas Detection	Combines gas detection directly into a wearable helmet with automatic fan activation for ventilation.	Closest technologies use handheld or separate gas detectors, which are not wearable and do not integrate ventilation measures.
Multi-Sensor Fusion	Combines gas, temperature, fall, and light detection into a single, unified system.	Current solutions address only individual hazards, requiring multiple separate devices, which are cumbersome and inefficient.
Real-Time Fall Detection	Uses an accelerometer and gyroscope (MPU6050) for accurate fall detection with impact confirmation and immediate alerts (LED + buzzer).	Traditional fall detection systems often have high false positives or require separate devices (e.g., smart bands), which are not integrated into helmets.
Light-Adaptive Feature	Automatically adjusts visibility in low-light environments by activating an integrated headlamp based on LDR readings.	Most existing helmets lack light sensors or rely on manual activation of lamps, increasing response time in low-light conditions.
Proactive Hazard Alerts	Provides instant visual (LED) and auditory (buzzer) alerts for detected hazards, ensuring the worker is aware of risks in real time.	Many solutions provide alerts via remote monitoring but lack immediate, on-site notifications for workers, increasing response time in emergencies.
Automatic Safety Systems	Activates a fan during high gas levels or extreme temperatures to ensure the worker's comfort and safety without requiring manual control.	Current helmets do not have integrated ventilation or automatic safety measures to mitigate hazards.
IoT Integration (Optional)	Transmits real-time data to supervisors or emergency contacts using Wi-Fi and APIs, enabling remote monitoring and enhanced safety.	Traditional safety helmets do not include IoT capabilities, making it harder for supervisors to monitor worker conditions in real-time remotely.
Compact, Wearable Design	All sensors and safety features are integrated into a durable, lightweight helmet, ensuring worker mobility and comfort.	Closest alternatives involve multiple separate devices, which can hinder movement and increase the risk of workers neglecting to use them properly.

Configurable Alert System	Workers can send "safe" messages or stop alarms using a button press, reducing unnecessary alerts and improving emergency communication.	Existing systems lack an interactive mechanism for workers to confirm their safety or stop false alarms, leading to inefficient safety operations.
Versatile Power System	Includes a rechargeable battery with BMS and optional solar panel for extended battery life in remote areas.	Traditional helmets lack integrated power systems, relying on external batteries or frequent replacements, reducing reliability in long-term applications.

10. **Has the invention been built or tested or implemented? If so, please provide the particulars of the first time it was successfully built or implemented (when, where, by whom, and evidence of this event including written or on-line pointers to documentary evidence): All testing details.**

Particulars of the First Build and Testing

When:
Initial prototype completed in November 2024.
Where:
Built and tested in a BML Munjal University
By Whom:
Built and tested by Nihar singla and team under the guidance of Dr. Sandeep.
Evidence:

- Written Evidence:
  - Logs of testing gas detection, fall detection, and temperature monitoring systems.
  - Sensor data readings during controlled experiments.
- Online Evidence:
  - Videos or photos of testing.
  - GitHub or documentation links showing system code and data logs.
  - Presentation slides or reports submitted to evaluators.

Testing Details

1. **Gas Detection Testing**
   - **Objective:** Verify MQ-2 sensor's response to various gas concentrations.
   - **Setup:** Simulated gas leaks using controlled gas sources (e.g., LPG, smoke).
   - **Result:** Successful detection of hazardous gases with appropriate alerts and ventilation activation.

2. **Temperature Monitoring**
    - **Objective:** Test the DHT11 sensor's ability to monitor temperature.
    - **Setup:** Exposed the helmet to varying temperatures using heat sources.
    - **Result:** Accurate temperature monitoring with timely visual alerts.

3. **Fall Detection Testing**
    - **Objective:** Validate MPU6050's ability to detect free fall and impact.
    - **Setup:** Simulated falls by dropping the helmet from a safe height.
    - **Result:** Successful fall detection with low false positives.

4. **Light Sensor Testing**
    - **Objective:** Test the LDR sensor’s light adaptation functionality.
    - **Setup:** Exposed the helmet to low-light conditions and observed automatic headlamp activation.
    - **Result:** Headlamp activated effectively in dark environments.

5. **Alert System Testing**
    - **Objective:** Verify the buzzer and LED responses for all detected hazards.
    - **Setup:** Combined gas, temperature, fall, and light scenarios in controlled conditions.
    - **Result:** All alerts (LED, buzzer, fan) triggered appropriately.

6. **Power System Testing**
    - **Objective:** Validate battery performance and BMS efficiency.
    - **Setup:** Conducted continuous operation tests to measure battery life and charging safety.
    - **Result:** Battery performed well for extended periods with stable power delivery.

7. **IoT Functionality Testing**
    - **Objective:** Test Wi-Fi-based remote alerts via WhatsApp API.
    - **Setup:** Configured Wi-Fi and cloud connectivity. Simulated fall and gas detection to send alerts.
    - **Result:** Alerts successfully sent with accurate information.

11. Briefly state when and how you first conceived this idea?

Ideally, the Smart Safety Helmet was first imagined while attempting to come up with an idea for a group assignment for our IoT module. Our teaming partners focused on potential harms that subjects encounter in dangerous areas such as mines and industrial places. It became clear that workers require a wearable device that constantly tracks and reminds them about their surrounding risks, including toxic gases, hot/cold temperatures, and falls.

Looking at the current available safety solutions and their shortcomings in addressing the problem at hand, a new concept of a smart helmet with integrated sensors for safety and early sign of hazard signals was proposed. There are no lone geniuses in the world, even though revolutionary ideas for product development originate in brainstorming sessions, serious research, and input from our teachers and many hours of work it took to come up with this invention today.

12. Have you sold, offered for sale, publicly used or published anything related to this invention? If yes, please briefly explain the dates and circumstances. List those individuals to whom you have revealed your invention. Were non-discloser documents signed prior to discloser in each case? Please state any deadlines of which you may be aware for filing an application on this invention.

No, the invention has not been offered for sale; public use or displayed in public in any form or published. All development, testing, and implementation have been done in directed environments exclusively for learnings and researches. This invention has not been disclosed to any other persons apart from the team members and academic supervisors thus there was no need for non-disclosure agreements. There are no bars or any poster events limiting the filing of the patent application at this instance.

13. Include any reasons that your invention would not have been obvious to someone of average skill in the art.

Integrating as many as four types of sensors—gas, temperature, fall, and light—into one wearable safety helmet targeting industrial workers is unusual. Although there are single sensors to measure the level of gas, temperature or to detect a fall, the idea of syncing all of them into one, in a helmet that will be functional and not bulky, is unique. This would not have been apparent to one working in the area with only one kind of sensor or working in a single domain Safety System.

1. Real-Time, Multi-Hazard Alerts:

It is useful to occupy several safety dangers (of a gas degree, temperature, fall, and vision) at the same time and give out alarms acoustically and visually at the same time (buzzer and LED) in the same component. All the existing solutions about safety precautions are based on definite once-only methods of danger recognition and signalization, including the lack of an operational, self-processed safety system with multiple ways of feedback reception.

2. Proactive Safety Measures:

The other attractive feature is the possibility of an automatic fan for the gas or temperature danger. As it stands, no helmets provide safety by triggering air circulation in response to things such as gas or heat, without the need for user input. Thus, using environmental readings to set up the fan and emit the alerts introduces considerable innovation.

3. IoT Integration for Remote Monitoring:

Most industrial safety solutions are isolated/sub- systems with no remote monitoring and data acquisition integration features. Perhaps the single biggest innovation our helmet has on the simple hard hat is that it can connect to a network (Wi-Fi or IoT) and send data and alerts to supervisors or contact persons – a level of networked safety not afforded by standard safety equipment.

4. Ergonomics and Comfort in a Safety Helmet:

Integrating high-tech sensor modules and components and at the same time ensuring that it still comfortable, lightweight and can be worn for a long period without affecting the performance of the worker designing the helmet will pose an innovative design solution that may not be easily observed or easily understood. Embedding technology into this final product requires engineering not used in conventional safety helmets, particularly in regards to weight and comfort.
These factors constitute the Smart Safety Helmet as a novel invention that does not offer merely an incremental improvement over the existing technologies but offers a totally new product that had not previously occurred to any one as a solution to the multiple connected facets of industrial safety because it requires the integration of different techniques and apparatuses in a single product that no mere improvement in safety equipment and technology expertise would provide.

14. Additional comments by inventor (if you want to give more details out of scope of this IDF).

The Smart Safety Helmet is developed with the objective of improving the welfare of those industrial people and the miners who are subjected to many environmental risks. The combination of several safety products into one helmet should decrease the hazards of industrial conditions, which include toxicity of gases and vapours, high and low temperatures, falls, and limited visibility. These IoT features of helmet provide real-time monitoring and communication to alert and inform the workers and their supervisors and contacts in case of working in unsafe conditions.

The lively features of the invention include its simplicity in operation, wearing comfort, and anticipatory warning mechanisms. Our goal is to minimize the number of devices a person needs

to use to ensure his or her safety at work by combining gas detection, temperature monitoring fall detection all in to one product.

This invention is likely to become useful in increasing the safety at the workplace by providing an innovation that includes real time monitoring and automatically triggers the safety mechanisms. It can be applied to other industries associated with risky conditions including the oil and gas industry, construction and chemical industries.

15. Drawings/Flowchart/Table