



A Smart Gas Cylinder Safety System: A Review of Sensing, IoT Monitoring and Automatic Protection Approaches

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Abstract. Liquefied petroleum gas (LPG) is a common household and commercial fuel, but undetected leaks and unexpected cylinder depletion create serious safety and convenience risks. Internet of Things (IoT) technology is increasingly proposed to monitor cylinders continuously, warn users and, in some designs, act automatically. This paper presents a focused narrative review of five peer-reviewed studies published between 2021 and 2024 in Elsevier, MDPI, IEEE, Springer and Balkan Journal of Electrical and Computer Engineering venues that propose smart LPG cylinder safety systems. The review compares sensing (MQ-series gas sensors, load cells, temperature sensors), control and communication (Arduino-class and Wi-Fi microcontrollers, cloud platforms, SMS and app alerts) and protective action (buzzers, exhaust fans, regulator or valve shut-off, automatic refill booking). The reviewed systems share a common architecture of gas sensor, load cell, microcontroller and cloud alerting, and differ mainly in the actions they trigger and the analytics they add. Reported evidence is mostly prototype-level: quantitative accuracy, response time, sensor drift, long-term field operation, connectivity failure and cybersecurity are rarely reported. The paper contributes a comparative table, a gap analysis and a set of research directions for reliable, fail-safe smart cylinder systems.

Keywords: LPG safety; gas leakage detection; cylinder weight monitoring; Internet of Things; MQ gas sensor; load cell; automatic shut-off; smart home

I. Introduction

LPG is a popular cooking fuel owing to its high energy density, portability and relatively clean burning, yet it is highly flammable and a leak cannot be seen by the user. Leaks from the cylinder, regulator or distribution pipe can cause fire or explosion, and a cylinder that runs out unexpectedly disrupts cooking because replacement may take time [3], [9]. Safety work in this area therefore pursues two connected goals: early leak detection with protective action, and continuous level monitoring with timely refill.

IoT makes both goals affordable by connecting low-cost sensors to microcontrollers and to cloud or mobile applications [1]–[3]. Recent studies combine gas sensors with load cells so that one device detects leakage and estimates remaining gas, then notifies the user or the supplier. Some also add temperature sensing, usage analytics, theft detection or automatic shut-off [2], [3], [9].

This review asks: (i) which sensing, communication and actuation designs are used in recent smart gas cylinder safety systems; (ii) how they compare; and (iii) what limits their readiness for real deployment. Section II states the method, Section III reviews the studies, Section IV compares them, Sections V and VI give gaps and directions, and Section VII concludes.



II. Review Methodology and Literature Selection Criteria

Search. Publisher platforms and indexes (IEEE Xplore, ScienceDirect, SpringerLink, MDPI, DergiPark and Google Scholar) were searched for combinations of *LPG, gas cylinder, leakage detection, weight monitoring, IoT, smart home safety and automatic shut-off*.

Inclusion criteria. (a) Peer-reviewed journal article, book chapter or conference paper from a recognised publisher; (b) a proposed or built system that detects LPG leakage and/or monitors cylinder level; (c) IoT or networked alerting; (d) preferably 2021–2024, with 2018 and 2021–2023 items used only as supporting context.

Exclusion criteria. Non-peer-reviewed web projects, theses, studies on LPG-fuelled vehicles or non-LPG gases, and papers without an identifiable system description.

Selection. Five primary studies [1]–[5] were selected for detailed comparison and four supplementary studies [6]–[9] are cited for context only. Each record was checked against a publisher, DOI or repository page.

Limitations of the method. Direct logged querying of Scopus and Web of Science was not performed, so this review is narrative, not systematic, and study counts are not given. For some studies the analysis rests on the published abstract and bibliographic record, so details such as test results may be missing and are marked as *not reported* rather than assumed.

III. Literature Review

1. Weight-Based Level Monitoring with Leak Alarm

Edward et al. describe a compact smart platform for household, office and industrial use in Sub-Saharan Africa, where handling practices make LPG incidents a concern. A load cell continuously monitors the LPG level and raises an alert at predefined thresholds, and the system detects leaks and warns users with a buzzer and LEDs [1]. This is a local-alarm design, and the abstract does not mention remote notification.

2. IoT Cloud Platforms and Mobile Alerts

Oo proposes a household system that measures cylinder weight with a load sensor connected to an Arduino MKR WiFi 1010, publishes readings to the Wia IoT cloud, and sends an SMS through Twilio when the level falls below 20 %. An MQ6 sensor detects leakage, triggering a warning, alarm and an exhaust fan to reduce gas concentration [3]. Nithin et al. present a cloud-based IoT application using an MQ2 sensor, which can respond to several gases including LPG, propane, smoke, hydrogen, methane and carbon monoxide, and alert residents so the cylinder can be turned off [4]. The MQ2's response to multiple gases bears on the risk of false alarms.

3. Smart-Home Integration and Usage Analytics

Balogun et al. (LPG Smart Guard) use an MQ135 gas sensor, a load cell and a DHT22 temperature sensor. Their approach requires no modification of the cylinder, regulator valve or pipe, records daily, weekly and monthly usage, alarms on leakage, low gas level and unauthorised cylinder movement (theft), applies predictive analytics to consumption trends, and can automatically order a new cylinder when the level drops below a threshold [2]. It is the most feature-rich of the five.

4. Low-Cost Leak Prevention with Automatic Control

A Springer chapter reports an economical alarm module based on an MQ6 sensor, which is sensitive to propane and butane, aiming not only to detect a leak but to control it through an automatic safety action [5]. Supplementary studies add similar



ideas: weight and gas sensing with buzzer and Blynk app alerts [6]; leak detection with gas-concentration reduction [7]; Industry 4.0 condition monitoring with solenoid valve closure and fire-extinguisher activation [8]; and automatic regulator turn-off on leak detection with level monitoring [9].

IV. Comparative Analysis of Existing Studies

Table I summarises the primary studies. Results are not directly comparable because the studies report different metrics and test conditions.

Table 1: Comparison of Representative Smart Lpg Cylinder Studies

Author, year	Sensors / communication	Actions	Gaps (from record)
Edward et al., 2024 [1]	Load cell; gas sensor; local platform	Level alert; buzzer and LED leak alarm	No remote alert described; results not reported
Balogun et al., 2024 [2]	MQ135; load cell; DHT22; IoT app	Leak, low-level, theft alarms; usage analytics; auto-reorder	Accuracy not reported; no shut-off described
Oo, 2021 [3]	MQ6; load sensor; Arduino MKR WiFi 1010; Wia cloud; Twilio SMS	SMS below 20 %; alarm; exhaust fan	No valve shut-off; Wi-Fi dependent
Nithin et al., 2023 [4]	MQ2; cloud-based IoT	Alert so cylinder can be turned off	Multi-gas cross-sensitivity; manual shut-off
Springer chapter, 2021 [5]	MQ6; alarm module	Alarm; automatic safety action	Details to confirm from full text

All five use low-cost metal-oxide gas sensors and most add a load cell. The systems differ in their alert path (local buzzer, SMS, app, cloud), in whether the protective action is automatic, and in whether they add analytics such as usage trends.

V. Research Challenges and Identified Gaps

- **Limited quantitative validation.** The available records seldom report detection accuracy, response time, false-alarm rate or weighing error.
- **Sensor limitations.** MQ-series sensors respond to several gases and are affected by temperature, humidity, ageing and warm-up; calibration and drift handling are seldom discussed. This observation draws on the multi-gas behaviour noted in [4].
- **Manual or partial protective action.** Several designs only alarm; automatic regulator or valve shut-off appears in only some studies [5], [8], [9].
- **Connectivity and power dependence.** Cloud and SMS alerts fail if Wi-Fi or mobile networks are down, and the reviewed abstracts do not describe offline fall-back, battery backup or fail-safe states.
- **Prototype-level evidence.** Most systems are shown in controlled or demonstration settings with no long-term household field trials.
- **Security and privacy.** Remote valve control and usage logs raise authentication and data-protection questions that are not addressed in the abstracts.

- **Limited intelligence.** Threshold rules dominate; only the usage-prediction feature in [2] goes beyond them.

VI. Proposed Research Directions

- **Multi-sensor fusion and calibration:** combine gas, temperature and humidity sensing with periodic self-calibration to cut false alarms.
- **Fail-safe actuation:** a normally-closed, locally controlled shut-off valve that works without network access, with battery backup and manual override.
- **Edge intelligence:** lightweight anomaly detection for slow leaks and abnormal consumption on the microcontroller, with the cloud used for analytics.
- **Dual-path alerting:** local siren plus SMS and app notification with delivery acknowledgement.
- **Field validation:** multi-home, multi-season trials reporting detection latency, false-alarm rate and uptime.
- **Secure IoT design:** authenticated commands, encrypted links and clear data policies.
- **Supply-chain integration:** safe automatic refill booking and theft alerts, as started in [2].



VII. Conclusion and Future Scope

Smart gas cylinder safety systems have progressed from simple leak alarms to IoT platforms that combine gas detection, weight-based level monitoring, cloud alerts, usage analytics and, in some cases, automatic protection. The five reviewed studies show that low-cost hardware can deliver both safety and convenience, but the evidence is mainly prototype-level and rarely quantifies accuracy, reliability or long-term behaviour. Future work should deliver fail-safe automatic shut-off, calibrated multi-sensor detection, secure connectivity and field validation, followed by standards-oriented testing for household deployment.

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