

AI-DRIVEN PREDICTIVE MODELING FOR REAL-TIME LPG CONSUMPTION MONITORING AND AUTOMATED REFILL OPTIMIZATION

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Abstract – It is very essential for an efficient management and monitoring of Liquefied Petroleum Gas to guarantee continuous utility of valuable resources in the homes, and a greater sense of convenience for the users. This paper describes an AI powered prediction model for monitoring LPG usage in real time, and creating an automatic booking plan for refilling the LPG cylinder. The system has been developed as a web application that is based on Flask, and collects a user's input: cylinder weight, number of people in the home, start date of using LPG, and the user's contact details. Then, using those inputs, the system utilizes a rules-based predictive model to provide information on out-of-gas date (when the LPG will be depleted) and the daily usage of gas. The model uses the standard weight of a 14.2 kg cylinder of LPG to calculate the average daily usage, and find the remaining quantity of gas in the cylinder as well as estimate how many days it will be before the gas is exhausted. Once the gas has reached below the predefined threshold the system automatically sends out an email notification to the user ,and also automatically book for refilling, to avoid having a sudden shortage of gas. A low-cost, easy-to-use solution using a no-hardware, basic method of calculating consumption based on regular home usage. This project provides a practical and scalable solution for monitoring and managing smart home LPG.

Keywords – *LPG Monitoring, Predicting Model, Gas Consumption Estimation, Automatic Alerts, Booking Plan, Time-Based Prediction.*

I. INTRODUCTION

Liquefied Petroleum Gas (LPG), commonly is a type of gas that is used in many households as a cooking gas because of its efficiency, low cost, and being user friendly to operate. One of the major challenges for users of LPG is that they do not have a way of monitoring how much gas they have consumed. Users typically rely on either guessing how much gas they have left in their tank or physically checking the weight of the cylinder. These methods can lead to inaccurate estimation of remaining gas, which can result in unexpected out-of-gas situations for the user. Generally, this type of situation is extremely inconvenient for the user, therefore, the need for a smart and

efficient solution is apparent. With the rapid development of the Internet and the predictive analytics technologies, it is now possible to build a solution that will allow users to more accurately estimate their usage of LPG and receive timely alerts regarding how much gas they have left. The current project will build an intelligent LPG monitoring system by leveraging an Artificial Intelligence algorithm to predict gas consumption patterns and approximate the depletion date of the gas. The development of the system will use Flask, which will allow the system to be delivered as a web application, thus making it easy for users to access and use.

The system will collect the necessary inputs such as the weight of the gas cylinder, the start date of usage, the number of people living in the home, and the users contact information like mobile phone number and mail id and calculate an average rate of consumption and predict how much gas remains. It will then send out automatic mail notifications that remind the user that they are running low on LPG, and that it is time to refill. This method makes using LPG easier for the user and provides a better way for the user to plan for and continue their use of LPG without interruption. The proposed system bridges the gap between the traditional manual method and the intelligent automated solution to design an effective LPG management system.

II. LITERATURE REVIEW

A number of studies have been done that consider the issues and challenges related to the monitoring of LPG and the timely refill of LPG service.

Study 1 – This has provided a method for detecting LPG gas leaks using a GSM based system, wherein the device will detect a leak and then send SMS notifications to the user about that. This type of device is useful in emergency situations; however, it is unable to provide any predictive analysis of how long LPG run out.

Study 2 – They developed a machine learning approach for predicting LPG consumption through the analysis of historical usage data using ALGORITHMS such as linear regression and TIME SERIES for forecasting; which resulted in improved prediction accuracy. In comparison to traditional approaches, the new method provides

greater performance while requiring extensive datasets and complex model training.

Study 3: They developed a web-based LPG tracking system where users can manually input usage information to assess their LPG consumption; these solutions are straightforward and quick to implement, but do not enable automated intelligent alerting.

Based upon this analysis, we see that existing systems depends either real-time monitoring through hardware support or utilize advanced analytical techniques that are highly complex. Therefore there exists an opportunity for developing a more affordable, easier and automated solution. To fill this void, we designed our system, which combines a rule-based predictive model with automatic email alerting capabilities that allow users to monitor LPG usage and plan refills efficiently.

III PROPOSED METHODOLOGY

The proposed solution is a predictive LPG monitoring system that operates entirely from the web. The proposed monitoring system will allow users to predict their LPG use without needing for an additional hardware. The methods that will be used to predict LPG levels will include rule-based and prediction-based predictive methods. Users will also be able to give real-time information that will be processed by the system.

A. Data Acquisition

Users will begin providing data through a web-based application that is created using Flask. Users will provide the following data to determine their LPGs usage pattern:

- Weight of the LPG
- People Living in the House
- Date the Customer Started Using LPG
- Contact Number or Email
- Brand of LPG

This data will be used as the main factors that affect the use of LPG.

B. Feed Based LPG Consumption Model

The monitoring system will be based on an average capacity of an LPG as 14.2 Kg. It is estimated that an LPG will be used up daily in the home approximately 30 days. Therefore:

Average Daily Use = Capacity of the LPG Cylinder / 30 Days

The result will be a linear consumption model that shows that use of LPG will be equal during the time on which the LPG will be used.

C. Estimating LPG Usage by Time

To calculate how many days you have used your LPG, just subtract the date from which you want to start using your gas from today's date. Then you can determine how much gas you have used far now:

Used gas = Number of days you have used the gas × User defined average daily amount of gas used.

Remaining gas = Current weight of gas – Gas you have used so far.

If the result from all of the above calculations yields a negative number for remaining gas, then the system will reset to 0 lbs. remaining. This will maintain logical continuity.

D. Prediction of Gas Supply Depletion

To predict when the gas will run out, the system will add 30 days to the user-defined starting date of gas use. After that, the system will calculate the number of days remaining until the gas runs out:

Days remaining until the gas runs out = Predicted Date of Gas Running Out – Today's Date.

Thus, the user can clearly see how much longer the LPG supply will last in their home.

E. Remaining LPG Level

The system will show the remaining gas as a percentage of total capacity by converting the weight of the remaining gas to a percentage:

Percentage of Gas Remaining = (Weight of Remaining Gas/Total Weight at Full Capacity) × 100%

By utilizing the percentage based on total capacity, a threshold for low-usage gas is defined:

If the remaining gas is less than 25% full, there will be a warning for low gas level.

The user can visually see at a glance their current LPG status.

F. Notifications

An alert will be generated by the rule-based decision-making engine as below:

An automatic refill booking and a low LPG notification will be sent to mail automatically when there are 2 days remaining.

An urgent low LPG notification will be sent when there is only 1 day remaining.

SMTP protocol provides email notifications to ensure timely communications.

G. System Integration

All processing is taken care of in the backend of Flask and the results are dynamically delivered to the frontend. This integration allows:

- Real time processing
- Immediate feedback
- Automated notification

The proposed methodology utilizes time-based estimation, rule-based logic and web automation to create an effective and simple LPG monitoring solution. The linear model provides reliable predictions for typical household LPG usage, and is a foundation for future AI-based enhancements.

IV METHODS OF DELIVERY

The LPG Monitoring System has established methods that allow for accurate prediction, efficient calculation, and timely notification to the user. The methods will include data based calculation, rule based system model, and Web based implementation.

A. Data Collection

To collect data from the user, a web interface developed by the help of Flask is used for collecting input data such as the weight of the cylinder, start date, number of group persons, gas brand, and contact detail information. This method allows for the capture of the necessary parameters that affect LPG consumption.

B. Data Preprocessing

To prepare the collected data for processing and analysis, the data must be converted from the user's input into the required formats, such as transforming the date input from the user into a datetime data type, and verifying the numeric values such as weight and member count for processing purposes. This method will ensure that the data used to calculate the system's consumption of LPG is accurate and consistent.

C. Estimation of LPG Usage

The estimation of the LPG usage is calculated using the linear consumption model. The daily usage of LPG for each cylinder will be calculated using the known daily usage rate of LPG multiplied by the number of days in which the cylinder has been used (30 days).

D. Time-Based Prediction Methodology

The passed number of days from a given starting date is determined to provide a gas consumption estimate to derive remaining gas and estimated gas depletion date. Therefore, it provides the opportunity to perform predictive analysis based on future usage versus only current tracking.

E. Threshold Based Alert Methodology

The predefined threshold levels generate auto alerts and notifications for the following time periods based on remaining gas supply:

1 – 2 days worth of gas remaining will cause Refill Alerts to be issued. This allows for proactive notification that will allow for avoiding the chance of running out of gas.

F. Notification Procedures

Automatic Notifications in the form of Email Alerts are sent to users email accounts using the SMTP protocol. The message body for the Email Alerts will automatically be generated based on the predicted gas supply status of the user to allow for timely communication.

V ARCHITECTURE DIAGRAM

The LPG Monitoring System architecture uses unit and layer architecture for its design, which allows for efficient processing of data, scalability and automated alert generation. The initial layer is the user input layer, where information such as cylinder weight, start date, number of household members, brand of gas and contact information are received through a user-friendly web interface. Proper data acquisition and validation will occur at this layer prior to sending data to the backend. The backend of the system utilizes a Flask-based application that works as the central processing element of the system and performs tasks such as managing requests, pre-processing data, and connecting various functional modules together into one continual and seamless operational flow. The backend will also ensure continuous communication between the front-end interface and the computational logic that runs within the system. Prediction modules

will be used to estimate gas consumption, determine how much gas is remaining, and project a depletion date based on time dimensions and preset assumptions. Use of these models will provide the user with accurate and approved figures. Decision logic evaluating low gas levels and days remaining from gas cylinders along with decisions made based on those evaluations will determine notifications sent via SMTP email notifications automatically to users to ensure timely communication with users.

The results will also be dynamically displayed on the web interface, providing real-time processing, modularity, ease of maintenance, and seamless interactions between all parts of this architecture, therefore providing a system that is efficient and scalable for practical LPG monitoring applications.

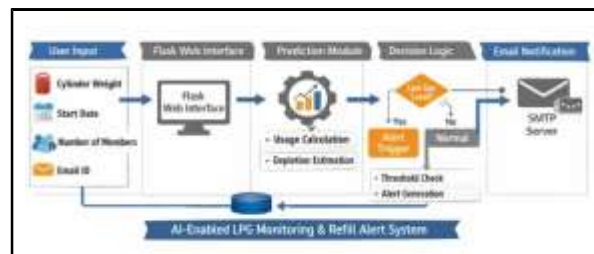


Fig 1: The Architecture diagram

VI INPUT

The contribution of users represents one of the central components of our proposed LPG monitoring system; as a result, the information supplied by users will be essential in order to make accurate predictions and carry out sound analysis. The user inputs to the system come from a web interface developed using the Flask framework; thus, the user interface is designed to be easily used, available and real-time. This user interface enables users to input LPG use-related data that are subsequently sent to the back-end of the system for further processing and calculations (shown in the diagram below).

Cylinder Weight (KG): Represents the total weight of this is a primary measure used when estimating the remaining gas and assessing the trends of LPG consumption over time.

Start Date Of Use: This input is the date on which the user first used the LPG cylinder. This data point is essential in calculating the past days from cylinder start of use .

Number of Household Members: Number of household members constitutes an indicator of how much gas will be consumed this input will continue to enhance the future development of models.

Brand of LPG: The brand name of the LPG supplier or type of cylinder is used however is not strictly used in present day calculations.

Contact information: Contact information like phone number and email address is used for sending automatic notifications like low gas alerts, refill reminders and automatic refill request when refilling.

```
BEGIN
SET the cylinder_capacity = 14.2 KG
SET the standard_days = 30 days
INPUT gas weight, number of members, start_date, brand, email
CONVERT the start_date to date
SET the current_date = today
CALCULATE :
avg_usage = cylinder_capacity / standard_days
days_passed = current_date - start_date
used_gas = days_passed × avg_usage
remaining_gas = weight - used_gas
predicted_empty_date = start_date + standard_days
days_remaining = predicted_empty_date - current_date
IF remaining_gas < 0 THEN
    remaining_gas = 0
END IF

CALCULATE level_percentage = (remaining_gas / cylinder_capacity)
× 100
IF level_percentage < 25 THEN
    DISPLAY "Low Gas Alert"
END IF

IF days_remaining == 2 THEN
    SEND email (auto refill alert)
ELSE IF days_remaining == 1 THEN
    SEND email (urgent alert)
END IF

DISPLAY remaining_gas, level_percentage, days_remaining,
predicted_empty_date,

END
```

The predicted output of the proposed system provides a structure for presenting the results of the predictive model to the user as well as a way to present both quantitative and qualitative outputs from processed input data and estimated consumption. The system calculates the remaining quantity of LPG in kilograms, which is the estimated available gas after all uses are taken into account prior to the specified time that has elapsed. The remaining gas, as a percentage of total cylinder capacity, will provide a normalized representation of the available amount of gas for ease in understanding.

The predictive model also provides an estimate of the number of days that gas will remain in order to be completely used, and will provide an estimate of when the cylinder of gas will be emptied. To assist with analytical understanding, the system will also show the average daily consumption from its predefined and calibrated capacity. In addition to the numbers provided by the output of the system, a rule based alert system is available to provide notice to users when the amount of gas is less than the amount specified as the alert threshold.

An automatic mailing process will be activated when the estimated days remaining to have gas left exceeds defined critical thresholds; this will raise alarm and provide users with an early opportunity to schedule a refill. The web based interface will provide real-time results of the predictive model as well as allow users to interact with the predictive model and make better-informed, more appropriate judgments about consuming gas within their homes and businesses.

IX RESULT

The Flask-operated website and LPG monitoring tools were developed through the testing of multiple types of input data for performance and effectiveness. It was found that the LPG monitoring system estimated the amount of LPG left over, as well as the refill time period based on the user's input of the price per liter (or gallon) and cost per liter or gallon of LPG to be used.

In addition, the output interface provided critical parameters that the user could see, including the current amount left of gas, the percent of the tank that is full, and days left until refill. This would allow users to make an informed decision as to whether or not there is enough LPG left to use and time to plan for a refill on LPG.

The alarm function of the LPG monitoring system worked as intended since the user received alarms when the amount left gas was below the alarming threshold, as designated by the user, and provided adequate notification via email before 1 or 2 days prior to needing more LPG to allow the user to schedule/plan for a refill.

It should be noted that the system made the assumption that the user's gas consumption is constant which could lead to a low level of error in the accuracy of prediction of LPG used.

X SCREENSHOTS

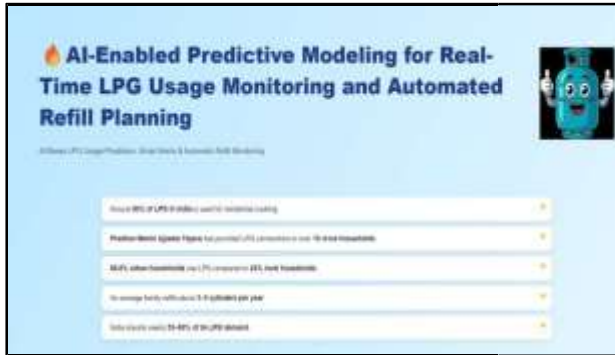


Fig 1: Home Page Displaying Description About LPG Consumption



Fig 2 : Input Interface Used For Entering User Data

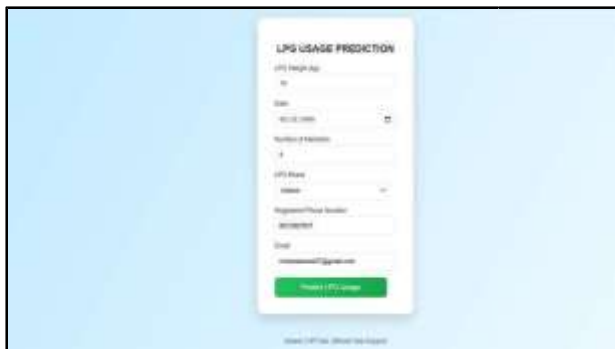


Fig 3 : Web interface showing user-entered input data.



Fig 4 : Output Screen Displaying predicted LPG usage and LPG booking automatically



Fig 5: Alert displayed when LPG level is low and nearing depletion (2 days remaining).



Fig 6: Output Screen Displaying predicted LPG usage

XI. CONCLUSION

In this paper a web-based LPG monitoring system using predictive modeling has been proposed and implemented to address the challenges faced with manual gas usage tracking and unexpected gas depletion. The system effectively uses inputs provided by users and a rule based estimation approach to predict the gas consumption, remaining quantity and depletion timeline. By combining automatic

alert mechanisms that includes email notifications and the system make sure timely user awareness and facilitates proactive refill planning.

The results show that the proposed model gives a good accuracy for common household usage patterns without being expensive. The system is easy to deploy and has removed the use of extra devices unlike hardware-dependent solutions which require extra hardware.

But the existing method involves a linear consumption model, which may not be able to capture the fluctuation in the real world application. The addition of IoT sensors to achieve real-time data acquisition and machine learning algorithms to make adaptive and more accurate predictions can be considered in the future.

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