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Revolutionizing Petroleum Retail Outlet Operations: Artificial Intelligence for Improved Efficiency and Customer Experience

Jeenath Laila N[1]*, Mohamed Rizwan[2]

[1]Department of Computer Science and Engineering, Government College of Engineering, Tirunelveli,
Email: jeenathlaila@gcetly.ac.in
[2]Research Scholar, Karunya Institute of Technology and Sciences, Coimbatore,
Email: mohamedrizwan@karunya.edu.in
*Corresponding Author

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ABSTRACT
The petroleum retail outlet operations have become increasingly complex due to the growing demands of the industry. To keep up with the competition, retailers are seeking ways to optimize their operations, improve customer experience, and increase profitability. Artificial Intelligence (AI) has emerged as a powerful tool to help retailers achieve these objectives. In this paper, we explore the implementation of AI in petroleum retail outlet operations, including stock maintenance, sales delivery, Retail Outlet (RO) maintenance, amenities requirement, safety protocols, and customer retention. We discuss the benefits of AI in improving efficiency, reducing costs, and enhancing customer experience. We also highlight some of the challenges that retailers may face when implementing AI in their operations, including data quality, security, and ethical concerns. Overall, the implementation of AI in petroleum RO operations has the potential to revolutionize the industry and deliver significant benefits to both retailers and customers alike.

Keywords: Petroleum retail outlet operations, Artificial Intelligence (AI), Stock maintenance, Sales delivery, RO maintenance, Amenities requirement, Safety protocols, Customer retention.

1. INTRODUCTION

The petroleum retail outlet industry has been undergoing significant changes due to the increasing demands of the market. To remain competitive, retailers are looking for ways to optimize their operations, improve customer experience, and increase profitability. AI has emerged as a powerful tool to help retailers achieve these objectives. In this paper, we will explore the implementation of AI in petroleum retail outlet operations, including stock maintenance, sales delivery, RO maintenance, amenities requirement, safety protocols, and customer retention. We will discuss the benefits of AI in improving efficiency, reducing costs, and enhancing customer experience, as well as highlight some of the challenges that retailers may face when implementing AI in their operations.

The use of AI in the petroleum retail outlet industry has become increasingly popular due to its ability to optimize operations and enhance customer experience. AI can be used for a wide range of applications, such as predicting demand, optimizing inventory levels, and improving supply chain management. By analyzing customer data, AI can also help retailers understand customer behaviour and preferences, allowing them to tailor their offerings to meet customer needs.

One of the main areas where AI can be implemented is stock maintenance. AI can help retailers optimize their inventory levels, reducing the amount of stock that is wasted or left unsold. By analyzing sales data and predicting future demand, AI can help retailers make informed decisions about when to restock and how much stock to order. This can help retailers reduce costs and improve efficiency, while also ensuring that they always have the products that customers want.

Another area where AI can be implemented is in sales delivery. AI can help retailers optimize their delivery routes, reducing the time and costs associated with delivering products to customers. By analyzing traffic patterns and customer data, AI can help retailers determine the most efficient delivery routes, reducing the time and costs associated with delivery.

AI can also be used to optimize RO maintenance. By analyzing data from sensors and cameras, AI can help retailers identify potential maintenance issues before they become major problems. This can help retailers reduce downtime and repair costs, ensuring that their operations are always running smoothly.

In addition to optimizing operations, AI can also be used to improve customer experience. By analyzing customer data, AI can help retailers understand customer behavior and preferences, allowing them to tailor their offerings to meet customer needs. This can help retailers build stronger relationships with their customers, improving customer loyalty and retention.

Despite the many benefits of AI, there are also challenges associated with its implementation. One of the main challenges is data quality, as AI algorithms rely on accurate and up-to-date data to be effective. Security is also a concern, as retailers need to ensure that customer data is protected from unauthorized access. Ethical concerns related to the use of AI also need to be addressed, as retailers need to ensure that they are using AI in a responsible and transparent manner.

The implementation of AI in petroleum retail outlet operations has the potential to revolutionize the industry, delivering significant benefits to both retailers and customers. By optimizing operations, enhancing customer experience, and increasing profitability, retailers can stay competitive in a rapidly changing market. However, the challenges associated with AI implementation need to be carefully considered and addressed to ensure that its benefits are realized without compromising data quality, security, or ethical considerations.

2. LITERATURE SURVEY

Dogru et al. highlight how AI and ML have revolutionized automation and robotics over the past two decades. These advancements are transforming businesses, particularly in supply chain management. Smart technologies now enable real-time data collection, analysis, and forecasting. This study explores AI's role in operations management, focusing on healthcare, manufacturing, and retail. These industries drive AI innovations while facing critical challenges. We examine key obstacles and opportunities in AI adoption. Additionally, we discuss emerging research topics with significant value potential. Our analysis underscores AI's transformative impact on these sectors.

Zhanget.al provides an overview of the potential uses of AI and machine learning in petroleum retail outlet operations. The authors discuss several applications, including predictive maintenance, demand forecasting, and customer behaviour analysis. The paper provides a comprehensive overview of AI applications in the industry, which could be helpful for companies looking to implement AI. The authors also provide insights into potential future developments in the field. The paper does not include any empirical data or case studies, so the benefits and drawbacks of AI implementation are not directly demonstrated. Additionally, the authors do not discuss potential ethical concerns related to the use of AI in the industry.

Rahmanet.al. focuses on the use of machine learning for predictive analytics in gasoline stations. The authors describe a system that uses data from gasoline pumps, cameras, and sensors to predict fuel sales, inventory levels, and customer behavior. The system proposed by the authors could potentially improve operational efficiency and customer experience for gasoline stations. The paper provides technical details on the implementation of the system, which could be helpful for companies looking to develop similar applications. The authors do not address potential ethical concerns related to the use of customer data for predictive analytics. The study also does not include any empirical data on the effectiveness of the system.

Harunet.al. describes a system for using AI techniques to optimize site selection for petroleum retail outlets. The authors use data on population density, traffic volume, and competitor locations to develop a model for predicting the profitability of different retail site locations. The system proposed by the authors could potentially improve the efficiency and profitability of petroleum retail operations. The paper provides technical details on the implementation of the system, which could be helpful for companies looking to develop similar applications. The authors do not address potential ethical concerns related to the use of AI for site selection. Additionally, the study does not include any empirical data on the effectiveness of the model.

Fawzanet.al. explores the potential of AI in improving various aspects of petroleum retail outlet operations, such as inventory management, sales forecasting, and customer engagement. The authors argue that AI can help retailers make data-driven decisions, reduce operational costs, and provide personalized services to customers. The paper provides a comprehensive overview of the potential benefits of AI in petroleum retail outlet operations, including improved efficiency, cost savings, and enhanced customer experience. The authors also discuss the technical aspects of implementing AI, such as data analytics and machine learning algorithms. The paper does not address the ethical and security concerns associated with AI implementation in petroleum retail outlet operations. The authors also do not provide specific case studies or examples of AI implementation in this industry.

Thakur et.al. focuses on the use of AI for energy management in petroleum retail outlets. The authors propose a framework that uses machine learning algorithms to predict energy demand and optimize energy usage in real-time.The paper provides a detailed description of the AI framework for energy management and presents experimental results that demonstrate the effectiveness of the approach. The authors also discuss the potential cost savings and environmental benefits of AI-based energy management. The paper does not discuss other applications of AI in petroleum retail outlet operations, such as inventory management or customer engagement.

The authors also do not address the challenges of implementing AI in energy management, such as data quality and system integration.
Singhet.al. provides a comprehensive review of the literature on AI applications in petroleum retail outlet operations. The authors examine various AI techniques, such as neural networks and fuzzy logic, and their potential to improve different aspects of the operations, such as inventory management, sales forecasting, and customer engagement. The paper provides a comprehensive overview of the different AI techniques that can be applied in petroleum retail outlet operations, as well as their potential benefits. The authors also present case studies and examples of AI implementation in this industry. The paper does not address the challenges of implementing AI in petroleum retail outlet operations, such as data quality and security concerns. The authors also do not provide a detailed technical description of the AI techniques discussed in the paper.

3. Proposed System

In present scenario, petroleum sector is the most competitive business. Here we are going to study about implementation of AI in petroleum retail outlets for its operations and sales profitability. The RO operations involves mainly on the stock maintenance, stock sales delivery, RO maintenance, amenities requirement, safety protocols and customer retention.

3.1 Stock maintenance

The maintenance of the stock is one of the most important and primary requirement when it comes to petroleum retail outlet operations. There should always be a stock availability of minimum 3 to 5 days of sales in the under storage tanks (UST) of RO. This becomes easier when it is maintained through automation engineering. The everyday sales and stock data will be transferred to the Oil Marketing Committee (OMC) supply point and their database. Based upon which the required quantity will be ordered for the RO. Thereby maintaining the stock at all times.
The implementation steps for maintaining stock in petroleum retail outlets using AI are as follows:

Collect and analyze sales data: The first step is to collect daily sales data from the RO. This data can be analyzed using statistical methods to identify patterns and trends in sales. Assuming the daily sales data of a petroleum retail outlet as given in Table 1.

Table 1. Sample Daily sales data of a petroleum retail outlet

Day	Sales (in litres)
1	500
2	700
3	900
4	1000
5	800
6	600
7	400

Forecast future demand: Based on the sales data, future demand can be forecasted using time series analysis or other forecasting techniques. This will help to determine the quantity of fuel required to maintain the stock at the RO.
Calculate safety stock: Safety stock is the buffer stock that is maintained to cover unexpected variations in demand or supply. It is calculated based on the standard deviation of demand and lead time.
Calculate reorder point: Reorder point is the inventory level at which a new order should be placed to maintain the desired level of stock. It is calculated as the sum of the safety stock and the average daily demand during lead time.
Place order: Once the reorder point is reached, an order should be placed with the OMC supply point to replenish the stock.
Monitor and adjust: The stock level should be monitored regularly to ensure that it remains within the desired range. Adjustments can be made to the forecast and safety stock levels based on changes in demand or supply.
By implementing AI in stock maintenance, retailers can ensure that they always have sufficient stock to meet customer demand, while minimizing the costs associated with excess inventory or stockouts.

3.2 Stock sales delivery

Sales delivery is directly interlinked with stock maintenance. Based upon the sales delivery, the average stock has to be maintained in RO. Using AI and automation engineering in the sales delivery, we can get the exact quantity delivered of each and every sales which can be cross verified with the storage tank. Implementation of

AI and automation engineering gives a clear picture of each and every sale with the quantity delivered to the concerned vehicle. There are chances where the dispensing units may deliver wrong quantity due to repair in the suction pipe, mother board and other mechanical or electrical parts. The implementation of the AI will immediately alert the error in the Dispensing Unit (DU) to the automation system. Thereby always delivering a correct quantity to the consumer. In case if consumer raises a quantity dispute, we can immediately cross verify and reconciliate with the quantity of sales delivery made to that particular consumer with the help of Automation Engineering. Thereby avoiding delivery of wrong quantity to the customers.

The implementation of AI in sales delivery of petroleum retail outlet operations involves the following steps:

Installation of sensors: Install sensors in the dispensing units to track the quantity of fuel being dispensed.

Data collection: Collect data on daily sales and delivery of fuel from the dispensing units.

Data pre-processing: Clean the collected data by removing any errors, missing values or outliers.

Data analysis: Analyze the collected data to identify any patterns, trends or anomalies in the sales and delivery of fuel.

Training of AI model: Train an AI model using the collected data to predict the expected quantity of fuel delivery for each sale.

Testing and validation: Test and validate the AI model to ensure its accuracy in predicting the fuel delivery quantity.

Integration with automation system: Integrate the AI model with the automation system to enable real-time monitoring of sales and fuel delivery.

Error detection and alert system: Implement an error detection and alert system that notifies the automation system in case of any error or malfunction in the dispensing units.

Reconciliation system: Implement a reconciliation system that cross verifies and reconciles the fuel delivery quantity with the sales made to the customer in case of any dispute.

RO maintenance

The maintenance of the RO includes its neat and tidiness of the RO driveway area, sales building, office building, other kiosks and drinking water area-its equipments like water cooler, filter units, drainage pipes etc. and clean toilets. This can be monitored by the OMC through a feedback machine. The AI implementation through cameras installed within the RO premises will immediately alert the server database of the OMC in case of any irregularities. For example, placing the lube cartons in a wrong place or dumping of any other waste materials within the RO premises by either the RO Staffs or any other consumers. Thereby maintaining a neat and tidy RO.

The implementation steps for AI in the maintenance of the RO are as follows:

Installation of cameras: First and foremost, cameras need to be installed in the RO premises for monitoring and surveillance purposes. The cameras should be placed strategically to capture all the key areas like the driveway area, sales building, office building, kiosks, and the drinking water area.

Integration with AI: The camera feeds should be integrated with an AI system that can process the visual data captured by the cameras. The AI system should be capable of recognizing objects and patterns, and detecting any irregularities in the RO premises.

Alert system: The AI system should be equipped with an alert system that can send notifications to the OMC server database in case of any irregularities. For example, if the cameras detect any littering or dumping of waste materials within the RO premises, the AI system should immediately send an alert to the OMC server.

Feedback machine: The OMC can also set up a feedback machine at the RO premises for customers to rate the cleanliness and hygiene of the RO. The feedback machine can be linked with the AI system, which can analyze the feedback data and provide insights on the areas that need improvement.

Assume that a RO has installed cameras and integrated them with an AI system. The AI system detects that a customer has dumped a plastic water bottle within the RO premises. The AI system sends an alert to the OMC server, which then sends a notification to the RO manager. The manager immediately takes action and removes the plastic water bottle. The feedback machine installed at the RO premises shows that the customers are satisfied with the cleanliness and hygiene of the RO, and the AI system reports that there have been no irregularities for the past week.

3.3 Amenities Requirement

As per the Indian Government Statutory requirements, it is mandatory for every Petroleum RO to give free water, air and toilet facilities not only to the consumer or customer but also any passing public should be allowed to use these amenities in the RO. This includes basic operations of the air inflators, water coolers and toilets.

Implementing AI in amenities requirement can help in ensuring the availability and proper functioning of these facilities. Here are some implementation steps:

Install sensors and cameras: Sensors and cameras can be installed in the air inflators, water coolers, and toilets to monitor their availability and usage. This can be connected to an AI-powered system that can analyze the data and provide insights.
Analyze data: The data collected from the sensors and cameras can be analyzed by the AI-powered system to determine the usage patterns of these facilities. This can help in predicting when the facilities will require maintenance or refill of water.
Predictive maintenance: Based on the analysis, the AI system can predict when the facilities will require maintenance or servicing. This can help in reducing downtime and ensuring that the facilities are always available for use.
Remote monitoring: The AI system can also provide real-time monitoring of the amenities. In case of any malfunction, it can immediately alert the staff or technician to fix the issue.
Customer feedback: AI can also be used to collect customer feedback on the amenities. This can help in identifying areas that require improvement and provide a better customer experience.

3.4 Safety Protocols

A petroleum retail outlet is always a hazardous area. Hence its operations should always be taken extra care in order to avoid fatal accidents. Any mismaintenance or irregularities can create accidents or injuries in an RO. The unloading or decantation in an RO should be done with all safety protocols and suspension of sales. The AI in the fill pipes and under storage tanks will immediately alert the OMC system database, thereby suspending the Dispensing Unit (DU) sales. During decantation, it is safe to stop the sales and keep every consumer outside the RO premises. The AI cameras installed in RO will play a major role in the safety maintenance.
Implementing safety protocols in a petroleum retail outlet requires a systematic approach to ensure that all safety procedures are followed correctly. Here are some detailed implementation steps for the safety protocols:
Develop a safety policy: Develop a safety policy that outlines the safety measures to be taken during the operations of the RO. The policy should cover the safety procedures for all aspects of the RO's operations, including unloading, decantation, storage, and dispensing.
Train the staff: Train all the staff on the safety procedures and protocols to be followed during operations. They should be familiar with the safety policy and trained to respond appropriately in case of any emergency.
Install AI sensors and cameras: Install AI sensors and cameras in the RO to monitor the operations and detect any irregularities or potential hazards. The AI sensors and cameras should be able to detect any leakages or malfunctions in the dispensing unit and storage tanks.
Set up an OMC system database: Set up an OMC system database that is linked to the AI sensors and cameras. The database should be able to receive alerts from the sensors and cameras and automatically suspend the dispensing unit's sales in case of any emergency.
Conduct regular maintenance: Conduct regular maintenance on the RO's equipment and facilities to ensure that they are in good working condition. Any malfunctioning equipment or facilities should be promptly repaired or replaced.
Regularly test the safety systems: Regularly test the AI sensors, cameras, and OMC system database to ensure that they are functioning correctly. Conduct drills to simulate emergency situations to train the staff on how to respond appropriately in case of an emergency.
Display safety signs and instructions: Display safety signs and instructions in the RO to remind the staff and consumers of the safety procedures to be followed during operations. The signs and instructions should be clearly visible and easily understandable.
Review and update the safety policy: Regularly review and update the safety policy to incorporate any changes in the RO's operations or new safety measures that may be required.
By following these implementation steps, the RO can ensure that all safety protocols are followed correctly, and the staff and consumers are protected from any potential hazards or accidents.

3.5 Customer Retention

Customer retention is the simplest technique or tool to increase profitability or maintain the sales volume of a petroleum retail outlet. In order to retain the existing customer of any petroleum retail outlet or to bring in new customers it very important to maintain quality and quantity at RO, which can be done through following the proper instructions of the OMC and maintaining the above mentioned parameters.
In order to retain the customers of the RO, it is important to know and identify what type of walk in customer. Every single sales has to be recorded with the details of what type vehicle is it, and how often they walk in. Practically it is not at all possible to note down and maintain the list of every single vehicle coming into the RO for fuelling.
Hence AI plays a role in the data collection, analysis and maintenance of the fuelling customers. Through image processing, camera can installed for the point of sale wherein it scans the number plate of the vehicle which fuels in and details of the time, date and the quantity is also recorded. This Point of Sale (POS) scanning

machine can record every vehicles fuelling in. On a period of time, the analysis will be done on the repetition of fuelling and an alert will be given to the owners mobile number or system database in case of if the vehicle has not come in for fuelling for a longer time. This can be noted and analysed if required by getting a feedback from that customer. Thereby the customer data is maintained and the customers will also be retained if required. This will help in the customer retention process and the sales volume of the RO will not drop on a larger scale.
Considering two different outlets of the same Oil Marketing Company(OMC) in a same city or town has been considered with respect to their similarities in area, brand, visibility, amenities and reputation among the local public. Two consecutive years of sales have been considered for the two outlets A and B wherein for outlet A, AI is not implemented as shown in Table 2 and for outlet B, AI is implemented in the second year as shown in Table 3.

Table 2: Sales volume of Outlet A without AI

S.No	Product Name	Appx. Volume of sales- 2021 (in Litres)	Appx. Volume of Sales-2022(in Litres)
1.	Petrol	7,20,000	6,80,000
2.	Diesel	11,00,000	11,10,000
3.	Lubricants	2400	2300

Table 3: Sales volume of Outlet B without and with AI

S.No	Product Name	Appx. Volume of sales- 2021 without AI (in Litres)	Appx. Volume of Sales-2022 with AI (in Litres)
1.	Petrol	6,05,000	6,50,000
2.	Diesel	12,00,000	13,50,000
3.	Lubricants	1900	2100

Here are some general steps that could be followed to implement an AI-based customer retention solution for a petroleum retail outlet:
Define the problem: The first step is to clearly define the problem that the solution aims to address. In this case, the problem is to identify and retain customers of the RO by collecting data on their fueling patterns and sending alerts when a customer hasn't fueled up for a while.
Collect data: The next step is to collect data on fueling patterns. One way to do this is to install a camera that can scan the number plate of the vehicle and record the time, date, and quantity of fuel. This data can be stored in a database for further analysis.
Preprocess data: Once the data is collected, it needs to be preprocessed to remove noise, errors, and irrelevant information. This involves cleaning, transforming, and aggregating the data into a format that can be used for analysis.
Train a machine learning model: The next step is to train a machine learning model to identify patterns in the data and predict when a customer might not fuel up for a while. This can be done using techniques such as clustering, classification, and regression.
Evaluate model performance: After the model is trained, it needs to be evaluated to determine its performance. This involves using a test dataset to measure the accuracy, precision, recall, and F1 score of the model.
Deploy the model: Once the model is trained and evaluated, it can be deployed in a production environment. This involves integrating the model into the existing POS system and setting up alerts to notify the owner when a customer has not fueled up for a while.
Monitor and improve the model: Finally, the model needs to be monitored and improved over time. This involves collecting feedback from the customers, analyzing the performance of the model, and updating the model as needed to improve its accuracy and effectiveness.

4. CONCLUSION

The petroleum retail industry is constantly evolving, and retailers need to adopt innovative technologies to stay competitive. Artificial Intelligence has emerged as a game-changer in this industry, providing retailers with new opportunities to optimize their operations and enhance customer experience. AI can be leveraged for stock maintenance, sales delivery, RO maintenance, amenities requirement, safety protocols, and customer retention, delivering significant benefits such as improved efficiency, reduced costs, and enhanced customer satisfaction. However, retailers must be aware of the challenges they may face when implementing AI, including data quality, security, and ethical concerns. By addressing these challenges and implementing AI in a responsible and sustainable manner, retailers can revolutionize their operations and achieve long-term success. Overall, the potential benefits of AI in the petroleum retail industry are significant, and retailers who embrace this technology are likely to enjoy a competitive advantage over their peers.

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