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A review on Cold Storage Monitoring system and Data Analysis

Siva Priyanka S, and Arun Kumar G
ssp.ece@kitsw.ac.in and b20ec192l@kitsw.ac.in
Department of Electronics and Communication, KITS Warangal, Telangana, India

ABSTRACT
Cold storage is a warehouse where all the essentials are being stored like agricultural products, medicines, pharmaceutical products, chemicals, Food products like frozen food, seafood, and food grain in order to preserve and prevent loss. Cold Storage is a developing sector all around the globe. Which needs a maximum development in order to preserve the products for a longer duration. For maintaining those products for a long duration these need to be well preserved to avoid spoilage of those items. A constant temperature, humidity, light intensity etc. needs to be maintained inside the storage unit. But here comes the major issue without human intervention it is not possible to maintain the temperature constant manually, with the help of IoT monitoring systems those temperatures can be monitored without any human intervention. The data collected by the sensors present will be stored in the cloud. Artificial intelligence methods like Machine learning and Deep learning algorithms made analyzing of data easy.

Keywords:

Cold Storage, Machine Learning, IoT, Deep Learning

1. INTRODUCTION

According to the report produced by NABARD (the National Bank for Agricultural and Rural Development), India is a significant producer of several perishable items [1]. India, while being a developing nation in every way, wastes the most food of any country in the world. Several agricultural products and pharmaceutical commodities, such as medicines, vaccines, chemicals, and numerous types of seafood, are at a high risk of being wasted. These items consist of those produced in the course of daily life. This is because their grades are decreased before they are distributed to customers [2]. Consequently, this is happening for a number of reasons. Nevertheless, one of the key and most crucial is that the things being produced lack access to a suitable storage or cold storage system. An efficient cold storage system is the most essential element of the solution to this problem.

In recent years, both developing and developed nations have boosted their use of cold storage facilities. Before they can be sold to customers, it is necessary to accurately manage and maintain the conditions of temperature, humidity, light, oxygen, and many other factors for the vast majority of things that must be stored [3]. so as to overcome those hurdles. Each component requires monitoring and maintenance, which makes the Internet of Things (IoT), machine learning methods, deep learning methods, edge computing,blockchain and big data analytics conceivable. In order to monitor the features of cold storage, the newly designed methods use cost-effective components. The Internet of Things (IoT) and wireless sensor networks (WSN) have enabled the remote and simple monitoring of such features using cloud computing techniques [17]. This has made time and money savings feasible. The end-user may monitor these parameters using these methods, which include remote monitoring via an Android mobile application and a web server [4].

In the topic of monitoring for cold storage, significant progress has been achieved in the previous years. Technologies like Internet of Things (IoT), which use a huge number of sensors and wireless sensor networks (WSN), were utilized to do new tasks [1]. In order to fulfil a variety of conventional methods, GSM[23] modules were used, and fuzzy logic was applied for automated monitoring. After the collection of data from the Wireless communication model, the data is analyzed by Machine Learning algorithms and Deep learning algorithms such as Support Vector Machine (SVM)[2], Random Forest (RF), Decision Tree (DT) [1], Multiple Linear Regressor (MLR)[30] , regressor algorithms and Deep Learning algorithms such as Convolutional Neural Networks (CNN)[27], Artificial Neural Networks (ANN)[14][30], Long Short-Term Memory (LSTM)[29] and KNN regressor [1]. Some proposed methods are based on Blockchain technologies [22]. Due to the use of machine learning and time series approaches [28], the area of predictive analysis has also seen a lot of significant improvements.

In this paper, we provide a complete review of the many methodologies being used to solve the problem of cold storage monitoring. In order to conduct this study, we choose to examine a sample of works that were first published between 2012 and 2022. We conducted searches using the phrases "artificial intelligence" and "cold storage monitoring" to choose these papers. The remainder of the paper is organized as follows. In Section II, the formulation of the monitoring of cold storage problem is presented. Section III addresses the monitoring systems used for cold storage. The data analysis based on machine learning is given

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in Section IV. Section V discusses deep learning-based data analysis. In conclusion, we evaluate the research on cold storage monitoring presented in the paper

2. PROBLEM FORMULATION

Due to the continued growth of the country's economy, many industries, including agriculture, manufacturing, the marine sector, and commerce, have realised the need for cold storage. However, in my nation, the degree of automation in cold storage is rather low, and the industry standard for the amount of energy consumed has been in place for a very long time [7]. There has been a significant decline in the quantity of retail industry research publications [5] addressing the temperature management of cabinets and refrigeration equipment. These publications address the subject. The vast majority of scientific research on the retail industry focuses on determining whether or not commodities stored in refrigeration equipment maintain the proper temperature or shelf life. It is very rare for farmers and warehouse workers to be unaware of the changes that are occurring since it is difficult to recognise them. As it is feasible to rescue the whole barrel of fruits and vegetables if timely information about this type of situation is received [6].

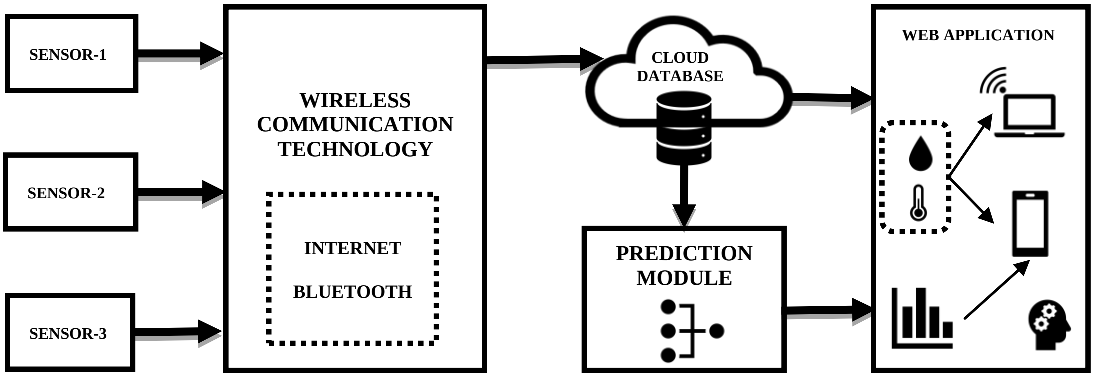

Figure-1: A genralized block diagram for cold Storage monitoring system

In agriculture sector food grains quickly begin their fast decomposition upon collection. The harvested crops must be kept in a location that not only assures their safety but also gives access to nutritious, high-quality food [8]. Monitoring perishable foods and materials is a continuing concern for the food and agricultural sectors, since even a little inaccuracy may result in a substantial loss of output [9]. Reducing food waste is one of the most essential actions that can be taken to enhance food security. In light of these concerns, it is of the utmost significance to establish an effective and efficient food storage management strategy. Establishing and maintaining a continuous cold storage monitoring from the point of manufacture to the ultimate consumer is the most crucial component in ensuring that products are in the best possible condition. These items might be perishables, such as fresh vegetables, flowers, fish, meat, or dairy products; pharametical commodities, such as drugs, blood, vaccines, organs, tissues, plasma, organs. It is also possible for some events to occur simultaneously. Temperature variations have an influence on their distinctive characteristics. If the proper conditions of the cold storage were not maintained, the length of the goods would be adversely affected [9].

3. COLD STORAGE MONITORING

Monitoring of cold storage facilities employs a wide variety of technologies. These technologies include sensor technology, Internet of Things (IoT)-based technology, wireless sensor networks (WSN)-based technology, cloud computing-based technology, and blockchain-based technology. These technologies are organized into groups based on the suggested applications, in which diverse technologies and equipment are used. In order to achieve higher levels of functionality, traditional technologies have been improved by learning from one another. The technologies used for cold storage monitoring are discussed below.

The majority of suggested solutions used Internet of Things (IoT) technology and sensor networks to monitor cold storage environmental parameters such as temperature, humidity, and light intensity etc., With the aid of wireless communication modules such as Node MCU and Raspberry Pi boards, the cloud receives the data from the wireless communication module. In a few of the solutions that have been proposed, users are notified when they reach a potentially hazardous threshold with the help of SMS and emails.

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3.1. Cold Storage Monitoring based on IoT

Every area of the nation's development is advancing, with the exception of cold storage and energy consumption, in which the nation lags behind. using intelligent technology, which offers a trustworthy and secure work environment and also contributes to the enhancement of system efficiency. To maximize storage in this market, sophisticated technologies such as frequency converter technology, PLC control, and a mix of IoT are often used. IoT, also known as information and communication technology (ICT) [10], is used to handle the cold storage management difficulties in India. ICT monitoring is more comprehensive than cold storage monitoring. ICT technology gave birth to IoT technology, which is more efficient and speedy. Most of the proposed methods enables the employment of wireless temperature, humidity, CO_2, gas, pressure, light intensity, vibration. With the help of wireless communication modules like ESP 8266, ESP 32, Raspberry Pi's with the help of built-in Wi-Fi the sensor data is communicated to the cloud.

The collected data is displayed on the dashboard using the MQTT protocol. The dashboard used in the systems are Thingspeak and Blynk, which is an open-source cloud-based dashboards. On the dashboard, the features of the warehouse are visible. If the dashboard identifies any anomalies, such as a fire or the presence of toxic gases, the farmer will be notified by SMS and email. A mobile application may be used to determine the alarm threshold, enabling the organisation to respond quickly, reduce waste, and maintain compliance while seeing temperature and location data. By replying to this SMS received by the server, the mobile user may turn on or off the warehouse fan [12]. Using ESP8266 and relay, temperature and humidity are regulated. At a certain temperature, the compressor and AC relay are activated. When relative humidity drops below a specific level, a relay activates a humidifier [13].

ICT also enables the regulation of product weight, the tracking of shipping expiration dates, and remote monitoring. In addition, the study examines the fundamental components of cold storage door insulation and different room cooling strategies, including air cooling, hydro cooling, ice cooling, and vacuum cooling [10]. The proposed model is capable of notifying under particular conditions, such as door opening and closing and energy use [5] and alarm system [13]. By opening the cold storage door with a swipe of the card, the sensor may be deactivated [15]. The vibration sensor warns the control centre anytime an unauthorised individual enters a restricted area. The infrared sensor is linked to the control centre through the remote module of the field controller [15]. A line-following robot-based remote inspection of warehouses [14]. The Raspberry Pi's built-in Wi-Fi delivers sensor data to the Thing-Speak Server. The instant messages that clients send are defined by platform specifications. Line-following robots monitor the area around the cold storage facility.

3.2. Cold Storage Monitoring based on Cloud Computing

The proposed methodology in the paper [16] provides remote monitoring of storage systems based on edge computing, which yields more efficient results than conventional systems and low power consumption with low latency. The real-time monitoring of multiple parameters via a cloud-based web page. Using the wireless communication module ESP32, the proposed model monitors parameters such as temperature, humidity, and light intensity using DHT-22 and Light Dependent Resistor (LDR) sensors. The proposed system publishes data to the cloud using NodeJS and the MQTT protocol. With the aid of an API key, cloud-based data is accessed. With the help of the REST API, the web server is designed to retrieve cloud-based data. The system also includes alarms that sound when any parameter exceeds a potentially hazardous limit.

The suggested technique in [17] constructs an intelligent IoT system for remote monitoring of these real-time information on a mobile device or laptop through a dashboard. According to the suggested technique, cloud computing is utilised to manage large amounts of data due to a lack of storage devices. The sensors generate a substantial quantity of data. Collecting and storing this massive quantity of data is a significant difficulty. With cloud computing, the issue has been resolved. This technique suggests a new conduit between data and the cloud, edge computing, which pre-processes the data prior to delivering it to the cloud.

3.3. Cold Storage Monitoring based on Sensor Network

The project designed in [18] includes a temperature and humidity monitoring system for small-scale produce storage. The system is mostly hardware and software. Arduino Mega2560, ESP8266, Zigbee, DHT11, and OLED display are hardware components. Arduino IDE, UART Assist, and Lighting. Blinker are software components. The primary control board can receive sensor data through ZigBee. WIFI module on core control board can package and transfer data to an Internet of Things platform for real-time smartphone monitoring of temperature and humidity changes. Mobile users can examine historical temperature and humidity curves.

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The invention [19] creates a light-powered, flexible temperature-sensing patch (LTSP). LTSP might power low-light applications without batteries. The LTSP flexible circuit is made up of a Polyimide (PI) film and a copper (Cu) circuit. A wireless device monitored the food packing temperature. A 13.56 MHz RFID or NFC reader, such as an NFC-enabled smartphone, can read the supercapacitor's data and voltage condition in real time. The wireless module's LCD shows the micro-cold supercapacitor's temperature and voltage when the display button is pressed. Data may be read via NFC readers. The LTSP may enhance food quality and safety by using light-energy-reused cold storage in supermarkets. Flexible solar cells, sensors, and electrical components might enhance compact LTSP packets.

The objective of this method in[20] is to monitor the cold storage parameters like temperature and humidity with the help of DT-11 sensor and a ESP 8266 module is used for collecting information from the sensors and sending those values to the ThingSpeak cloud. The values from the sensor can be monitored remotely on the web page from anywhere with the proper ThingSpeak credentials. The data from the sensors is also represented in the graphical format of last 24 hours. If there is any change in any of those parameters then with the help of external relay module which can operate the temperature and humidity inside the cold storage unit.

A prototype-based [21] where the items stored inside the cold storage unit are observed and data collected from them. The items present inside the unit are detectable and identified with the help of web camera fixed inside the cold storage. A load cell is used for weighing the objects. A temperature sensor is also used for temperature monitoring. With the help of the raspberry pi the data is collected from the load cell and camera and analysed when there is a less weight shown in load cell then it indicates shortage of stocks and notifies the user and sends the information to the user with the help of the mobile app.

3.4. Cold Storage Monitoring based on Blockchain

In the work provided [22], a blockchain-based multi-sensor monitoring system (WSN) is developed. K-means and SVM were used by quality assessment program to categorize and predict the quality loss of frozen seafood using K-means and SVM. Through constant monitoring of dynamic indicators, blockchain-based WSN monitoring provides data security and reliability. The drop in quality was precisely foreseen. K-means and SVM can forecast the loss of dynamic quality. The RMSE for the training set is 0.1502, whereas the RMSE for the test set is 0.1793. K-means and SVM has gained more accuracy. Food loss is decreased by enhancing the quality and safety management of frozen shellfish during cold storage.

3.5. Cold Storage Monitoring based on WSN

The proposed system in [23] regulates and monitors warehouse ambient conditions utilising temperature sensors, humidity sensors, smoke detectors, load cells, fans, LDR, microcontrollers, and GSM. Method reduces harvest-related food losses. When a sensor detects a high temperature, the microcontroller gets the reading and the fan comes on. If the sensor detects high humidity, the fan pauses and displays humidity. When warehouse sensors detect a change in the environment, they update the web server via GSM and reduce the danger level.

In the paper the proposed [24] model is built to monitor the cold storage with the help of Zigbee Wireless Sensor Network (WSN). the protocol used to for Zigbee WSN routing. A cluster tree algorithm was used with improved version and the selection of the nodes in the neighbour table is studied to find optimal path between Zigbee WSN in order to reduce the delay in between communication. the monitoring results are been observed in the LabView interface.

4. MACHINE LEARNING BASED PROPOSED MODELS

The author [25] advised using machine learning to detect problems in refrigeration and cold storage systems in a timely manner. Only the temperature and defrost state of refrigerator cases are used. The difficulty of predicting time series is reframed as one of categorization. Feature extraction utilises seasonality trend decomposition, pattern learning, and clustering. A random forest-based binary classifier was trained to identify problems in every refrigeration instance at any time. The author utilised information from 2,265 store freezers to support his claims. This technique has a recall rate of 46% for unobserved events, a lead time of 7 days, and an accuracy of 91%.

The article proposed [3] a paradigm for cold chain management that blends the Internet of Things with cloud computing, machine learning, and big data analytics to optimize cold transport. This design monitors, displays, tracks, and modifies attributes dependent on the platform. Using Model-Based Design, Data Analytics of data has improved. Utilizing Cuckoo Search, Ant Colony Optimization, and Artificial Bee Colony Optimization, data is optimized. In addition to the Cultural Algorithm and the Clonal Selection

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Algorithm, further optimization methodologies include the Cultural Algorithm and the Clonal Selection Algorithm Important sensor data was analyzed and computed with the assistance of big data and machine learning, and we used model-based architecture for data analytics.

An EIoT platform for ML-based cybersecurity research [26]. The EIoT system performed well in a machine learning-based cybersecurity investigation using XGBoost training. This article describes IoT-based solar water temperature monitoring. Random Forest can discriminate between normal and harmful temperatures based on temperature monitoring. Using a small number of labelled samples, an XGBoost model was constructed to steal the known target model to illustrate the assault on the IoT platform.

A prediction model that takes into account vehicle characteristics, starting and ambient temperatures, food loading and unloading method, and MKT measurement (MKT). Machine learning algorithms determine food quality in real-time along the cold chain in predictive data analytics [1]. When compared to Decision Tree Regressor and KNN Regressor with Ensembling, Random Forest Regressor with Boosting Ensemble Technique has the highest accuracy (99.98 percent). The accuracy of the KNN regressor is 72.10 percent.

An IoT-based system for monitoring the temperature and humidity of perishable goods during transit. Mean Kinetic Temperature (MKT) measures biochemical changes in food caused by fluctuations in temperature. Innovative cold chain solutions use machine learning algorithms to assess the quality of perishables. Machine learning enhances time-temperature prediction. Data is examined using methods of machine learning. The Random Forest algorithm has the highest accuracy of 98.67 percent compared to SVR and Decision Tree [2].

5. DEEP LEARNIG BASED PROPOSED METHODS

A theoretical model of a proposed food recognition capable CNN powered refrigerator [27] that would automate daily refrigerator operations. We constructed a convolutional neural network model to recognise 101 food types using a pre-trained model and transfer learning. Convolutional neural networks have tremendous promise for food classification. The accuracy of food detection was 94% during training and 92% during validation. The classification performance of our model is encouraging. It illustrates the viability of convolutional neural networks with transfer learning for this classification problem.

An IoT-based cold storage monitoring and alerting system [4]. Monitoring temperature, humidity, CO2 content, and light intensity decreases perishable loss. Android apps can forecast stuff. RTIMNS displays real-time cold storage conditions. Notifiable is frightening. Advancement RT-IMNS uses ANN to categorise goods as excellent, unsatisfactory, or troubling. Data Mining beats Compress Sending, Adaptive Nave Bayes, and Extreme Gradient Boosting. Forward propagation neural network model accuracy was 98%, CS, ANB, XGBoost, and DM models were 95.6%, 87.50%, 93.593%, and 90%, respectively. 100% correctness, recall, F1-score for good class, 98 for insufficient, and 98 for nervous.

System in [28] be analysed as a sequence of time-varying behavioural parameters. Four LSTM-based deep neural network architectures were evaluated. Using cold room data, their effectiveness in predicting demand response was proven. The best deep learning architecture for our data is stacked LSTM. Due to the nonlinearity and interplay of numerous modelling components, standard physical models have difficulty predicting the dynamic behaviour of a refrigeration system, particularly during electrical demand response periods. The ability of stacked LSTM to adapt and self-learn makes it a promising solution for this kind of challenge.

During demand response, we suggest studying the interior temperature and energy consumption in a cold room. Each time-varying parameter of a system's behaviour may be analysed as a time series. The study, adaptation, and comparison of four LSTM neural network topologies. Despite being trained and evaluated on bigger data sets, models struggle to provide test-based predictions. Certain models and forecasts are encouraging, indicating that deep learning may provide greater outcomes with data enhancements. Stacking LSTM looks to be the most effective deep learning architecture for our data [29].

Warehouse demand response is difficult (DR). DR occurs within the warehouse owing to thermal inertia, however during the DR phase, the air and product temperatures rise over the threshold. Four deep learning artificial neural networks (ANN) and traditional, stacked, directed, and convolutional LSTM were created to predict future temperature and power consumption during DR. Four separate sensor inputs and outputs were used to establish data availability and future prediction. A smaller data set was obtained. Four deep learning models provide equivalent results. The convolutional LSTM model predicts temperature best, while the bidirectional model performs better with less noise [29].

The predicted pH, TSS, aw, and MC based on the electrical properties of date fruits (Tamar) using ANNs [30]. ANN models were compared to MLR at each frequency. MLR models predicted fruit pH, TSS, aw, and MC less accurately than ANN models. 10 kHz electrical property testing indicated the optimal ANNs prediction model has 14 input neurons, 15 hidden neurons, and 4 output neurons. Our top ANNs model

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predicted pH with R2 = 0.938 and RMSE = 0.121, TSS with R2 = 0.954 and RMSE = 2.946, aw with R2 = 0.876 and RMSE = 0.020, and MC with R2 = 0.855 and RMSE = 0.803. This model improved pH, TSS, aw, and MC predictions for cold-stored date fruits with high R2 and low RMSE.

Table 1. A comparative Analysis of Existing Cold Storage Monitoring systems

Year, [Ref]	Technology used	Purpose	Limitations							
			Tem	Hum	LI	Gas	Pre.	DS	APP	NOTIFY
2021, [10]	IoT-based	Improved monitoring in cold storage	✓	×	×	✓	✓	×	×	×
2019, [5]	IoT-based, Cloud-based	To monitor temp. in refrigerated cabins	✓	×	×	×	×	×	×	×
2020, [6]	IoT- based	To monitor quantity of food in cold storage	×	×	✓	✓	×	✓	✓	×
2020, [7]	PLC, Fuzzy logic	Development of intelligent technology in cold storage	✓	✓	×	✓	✓	×	×	×
2018, [11]	IoT-based	To monitor the conditions in cold storage	✓	✓	×	×	×	✓	✓	×
2022, [31]	IoT-based	Improved monitoring in cold storage	✓	✓	✓	✓	×	×	✓	✓
2020, [13]	IoT-based	To provide smart monitoring cold storage	✓	×	×	×	×	✓	✓	✓
2018, [14]	IoT-based with cloud	Internet based real time monitoring	✓	✓	×	×	×	✓	✓	×
2020, [15]	IoT-based	To monitor the conditions in cold storage	✓	✓	✓	✓	×	×	×	✓
2020, [8]	IoT-based	IoT enabled remote monitoring	✓	✓	×	✓	×	×	✓	✓
2018, [32]	WSN, IoT based	Eco-friendly remote monitoring	✓	✓	✓	✓	×	×	✓	✓
2017, [23]	WSN, IoT based	To develop IoT based cold storage monitoring	✓	✓	×	✓	×	×	×	×
2021, [16]	Edge based, IoT-based	To provide a web-app deployed on the cloud	✓	✓	✓	×	×	×	✓	✓
2017, [24]	WSN, Zigbee	Zigbee based WSN monitoring system	✓	✓	×	×	×	✓	×	×
2017, [33]	GSM based	To detection of rotting potatoes	✓	✓	✓	✓	×	✓	✓	×
2020, [34]	IoT-based	To maintain the optimum temperature in vaccine carrier	✓	✓	×	×	×	×	✓	✓
2018, [35]	GSM	To prevent the loss of food products	✓	✓	×	×	×	×	✓	×
2020, [18]	Senor network	Management of cold storage to save energy	✓	✓	×	×	×	×	✓	×
2020, [19]	IoT-based	To develop solar powered cold storage	✓	✓	×	×	×	×	×	×
2020, [20]	Single-chip microcomputer	To develop fully automated monitoring system	✓	✓	×	×	×	×	×	×
2018,	Sensor	To identify the food quality inside the	✓	✓	✓	×	×	×	×	×

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[21]	network	warehouse								
2020, [22]	Blockchain, WSN	Quality verification of shellfish during cold storage	✓	✓	✓	✓	×	✓	×	×

Remarks: IoT stands for Internet of Things, WSN stands for Wireless Sensor Netwok, PLC stands for Programming Latch Control, GSM stands for Global System for Mobile communication, Temp. stands for Temperature, Hum. Stands for Humidity, LI stands for Light Intensity, Pre. Stands for Prressure, DS stands for Decision Support, AP stands for Andriod Application

Table 2. Artificial Intelligence Algorithms used in Cold Storage Monitoring Application

No	Algorithm	References	Algorithm type	Learning type
1	Artificial bee colony optimization	[3]	Swarm intelligence methods	Optimization algorithm
2	Extreme gradient boosting (XGBoost)	[26]	Ensemble	Supervised
3	Decision tree regressor Random forest regressor KNN regressor	[1]	Machine learning	Supervised
4	Random forest-based binary classifier	[25]	Machine learning	Supervised
5	Support vector regressor Decision tree Random forest	[2]	Machine learning	Supervised
6	Convolutional Neural Network (CNN)	[27]	Deep learning	Supervised
7	Artificial Neural Networks (ANN)	[4]	Deep learning	Supervised
8	Time series using Long Short-Term Memory (LSTM)	[28]	Gradient based learning algorithm	Reinforcement
9	Traditional LSTM Convolutional LSTM Stacked LSTM Bidirectional LSTM	[29]	Deep learning algorithm	Reinforcement
10	Artificial Neural Network (ANN) Multiple Linear Regressor (MLR)	[30]	Deep learning algorithm Machine Learning	Supervised

6. CONCLUSION

We provided an overview of various recently proposed methods for cold storage monitoring, including software-based and hardware-based methods. We evaluated each method and categorised them according to their methodology and the methods they employed. The preceding work revealed a trend in cold storage monitoring, we conclude. For real-time monitoring, Raspberry Pi, ESP8266, ESP32, ZigBee, and other wireless sensor networks are used as communication models (WSN). Moreover, the proposed methods store their data using cloud services. Using a web server hosted in the cloud, the parameters of the cold storage were remotely monitored. Some proposed methodologies for multipoint proposals employ cloud computing with edge computing, and big data analytics is also present. In the cold storage, the following variables were monitored: temperature, humidity, CO2 concentration, and light intensity. Temperature and humidity were the parameters most frequently monitored. In some proposed methods, models based on notification and alarming were also proposed. If any of the parameters exceeds the threshold, an alert or notification will be generated.

The proposed methods utilise machine learning (ML) algorithms for the majority of their data analysis. Some proposed methods use these machine learning (ML) algorithms for data prediction, while others use them for part analysis. Utilizing neural networks such as ANN and KNN regressor, the accuracy of the proposed model was compared to that of other models. Temperature and relative humidity were forecast using Multiple Linear Regression (MLR). Other algorithms, such as cluster trees, were utilised. Some methods of deep learning, including LSTM and convolutional LSTM, were employed. Table-1 A

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comparative analysis of proposed cold storage monitoring systems which contains proposed year, purpose of the proposed method, sensors used, weather the proposed system provides decision support or not, Android app option is available or not and notification alert is available or not. Table-2 Artificial Intelligence algorithms used in the methods with used algorithms and algorithm type and learning type of those algorithms.

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