# SMART INVENTORY MANAGEMENT SYSTEM

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*Abstract* — **(in 250 words)**

***Effective inventory management is crucial for businesses aiming to reduce waste, to optimize resources, and to satisfy the customer needs. Inventory systems often face challenges like overstocking, under stocking, and human errors. This research investigates a smart inventory management system that utilizes Internet of Things, Artificial Intelligence, and data analytics to improve accuracy and automation. By incorporating real-time tracking, predictive analytics, and automated restocking, the system facilitates better decision-making and cost efficiency. The study emphasizes how smart technologies enhances the operational efficiency, minimize the human involvement, and improve supply chain management. The results indicate that implementing smart inventory solutions boosts productivity, decrease losses, and promote a more environmental-friendly & Technically gained inventory control strategy.***

***Keywords*** *— Inventory Management, Internet of Things, Real time tracking, Cost efficient, environmental-friendly*

## I. INTRODUCTION

Effective Inventory Management is very crucial for any business because it directly affects profitability, customer satisfaction, and operational efficiency. However, many companies, ranging from small retailers to large corporations, encounter inventory-related issues that lead them to financial losses and inefficiencies. A common problem in the retail sector is poor stock management, which often results in either overstocking or stock outs. Overstocking raises storage costs and it leads to waste. While stock outs results in lost sales and can't satisfy the customers.

In the grocery industry, supermarkets usually face challenges with expires goods like dairy, fruits, and vegetables that remain unsold due to poor stock rotation, leading to waste. On the other hand, in the Industries, businesses often deals with supply chain break caused by inaccurate demand forecasting, resulting in delays in order to fulfillment and receives negative customer feedback. Similarly, manufacturing companies struggle with inefficient inventory tracking, which lead them to production delays and increased costs.

Traditional inventory management methods, which rely on manual tracking and periodic stock audits, are often inefficient and time-consuming. To address these challenges, businesses are increasingly adopting smart inventory management systems that includes Internet of Things (IOT), Artificial Intelligence (AI), and Data Analytics to enhance the accuracy, automate the processes, and facilitate real-time decision-making. This research explores how smart inventory management tackles these real-world challenges, improving operational efficiency, reducing waste, and optimizing supply chain performance. By including advanced technologies, businesses can shift to a more agile, cost-effective, and datadriven approach to inventory management.

## II. LITERATURE REVIEW

1)"IoT Based Smart Inventory Management System for Kitchen Using Weight Sensors, LDR, LED, Arduino Mega and NodeMCU (ESP8266) Wi-Fi Module with Website" BY Sifat Rezwan; Wasit Ahmed; Mahrin Alam Mahia; from this IoT Integration: Using Arduino Mega and ESP8266 for smart communication. And Sensor Utilization: Implementing weight sensors & LDR for inventory tracking

2)"A Review of Existing Inventory Management Systems" by MADAMIDOLA, Olugbenga Ayomide 1* , DARAMOLA Oladunni Abosede1 , AKINTOLA Kolawole Gabriel; Evolution from manual to smart inventory systems and Importance of automation & real-time tracking

3)"An IoT-based smart inventory system for the construction sector using RFID, sensors, and cloud to track materials in real time, reduce waste, and improve efficiency" by Rajesh Bose ,
Haraprasad Mondal;IoT & sensor integration for material tracking and real time monitoring

4)"Smart Solutions for RFID based Inventory Management Systems" by Ali Alwadi,Amjad Gawanmeh,Sazia Parvin,Jamal N. Al-Karaki ;RFID for fast & accurate tracking and Reduced manual errors & improved efficiency

5)"STUDY OF SMART INVENTORY MANAGEMENT SYSTEM BASED ON THE INTERNET OF THINGS (IOT)" by Souvik Paul and Atrayee Chatterjee ; IoT integration for smart tracking and Real-time monitoring via cloud & sensors

6)"Integration Of OLEDs And Display Drivers On PCBs" by Christian Kirchhof, Ulrich Todt, Fraunhofer IPMS ;PCB design for OLED integration and Power & signal management in displays

7)"Low cost ambient monitoring using ESP8266" by Ravi

Kishore Kodali; Kopulwar Shishir Mahesh ; ESP8266 for wireless sensor data transmission and Low-cost IoT implementation for smart systems

8)"Comparison of testing load cell sensor data sampling method based on the variation of time delay" by A F Hastawan, S Haryono, A B Utomo, A Hangga ; Trade-offs between speed & precision in data collection and Improving load cell performance in real-time applications

9)"Arduino IOT Based Inventory Management System Using Load Cell and NodeMCU" by Muhammad Naufal Mansor and Noor Anida Abu Talib ; Load cell integration for weight-based tracking and Real-time inventory monitoring on cloud/server

10)"Manufacture of Electronic Weighing Machine Using Load Cell " by Snehashis Das, Avijit Karmakar, Pikan Das, Biman Koley ; Calibration for accuracy & precision and Display & user interface design

11)"Smart Scale Tracking System Using Calibrated Load Cells" by Sedia Jaiteh; Su Farah Adillah Suhaimi; Tan Ching Seong ; Load cell calibration for precision and Automated weight monitoring & logging

12)"Assessing the ESP8266 WiFi module for the Internet of Things" by João Mesquita; Diana Guimarães; Carlos Pereira ; ESP8266's efficiency in IoT networks,Power and performance trade-offs and Scalability for smart applications

## III. METHODOLOGY

- Automatic Inventory Management System - Working

To know the number of packets available in the inventory, we have to know the total weight and the weight of an individual packet. For example, if the weight of 1 package is 10 grams and the total weight of the shelf for inventory is 100 grams, then we can easily calculate the number of packets available on the shelf by dividing the total weight by the weight of one individual pack. In the mentioned example, we will get 10 packs. So, the next question is, how to calculate or how to measure the total weight. The answer to that question is simple, we use a load cell. We measure the total weight, and we do all the necessary calculations with the help of a microcontroller. This way, we calculate the number of packages available in the inventory.

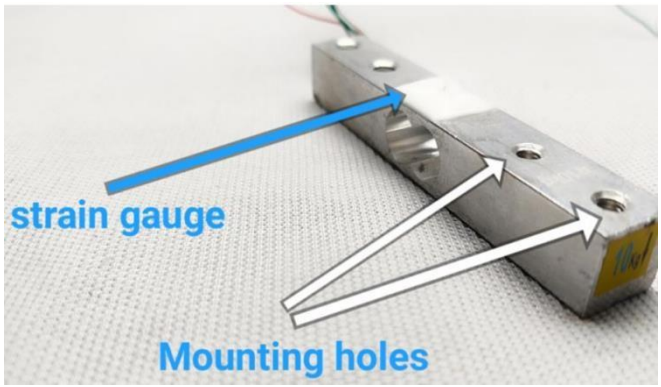
Now, let's upload this value to a cloud platform so that we monitor the status of our I**nventory management system** from anywhere in the world with the help of our **inventory management software**. In our project, we are going to use a NodeMCU(ESP8266) to do all the work.

- Components Required to Build the Automated Inventory Management System:-

1. NodeMCU - 1
2. Load Cell - 1
3. HX711 Load Cell Amplifier Module
4. 128*64 OLED Display
5. Connecting Wire

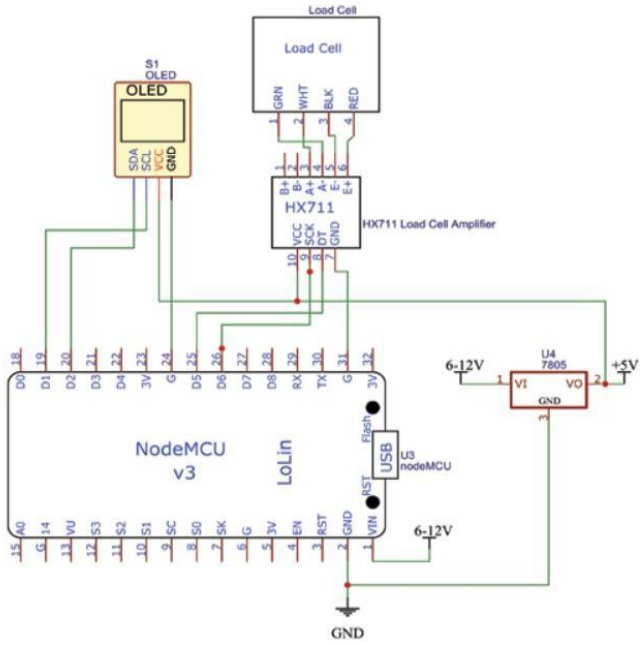
- Load Cell and the HX711 Load Cell Amplifier Module:

The key component of this project is the **load cell**. This is our load cell as we can see, one side is marked with five kilograms. We already noticed some sort of white protective glue over the load cell and four different wires of different colors are coming out, we will later see what is below in this white protective glue. First of all, these load cells are made of aluminum blocks and as we can see, the middle part of the material is thinner so that will be the point that will suffer deformation. A load cell has two sides, let's say right and left. Imagine that the cell is holding on the right side and the force is applied on the left side so that could bend the load cell. So, a small deformation will be created both on the top side and on the bottom side of the load cell. The top part will suffer tension and the bottom part will suffer compression. The aluminum bar is bending downwards on the left side. If we can measure this deformation, we could later measure the force that was applied to the aluminum block, and that's exactly we will do.




- Automatic Inventory Management System Circuit Diagram :-

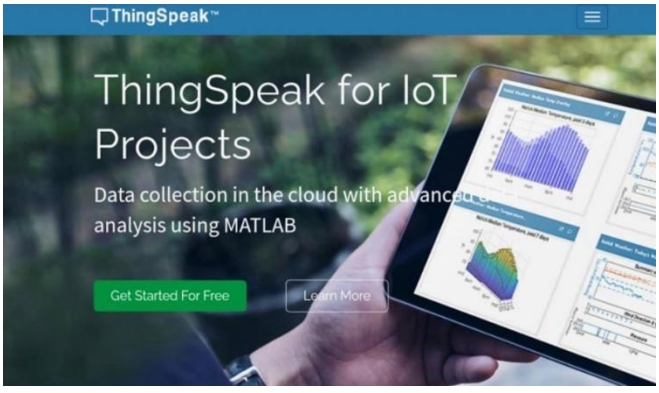
The complete circuit diagram for the **IoT Based Automated Inventory Management System** is shown below.




The circuit diagram of inventory is very simple. Here, we connected the OLED display to the I2C pins of NodeMCU, which are the D1 and D2 pins on the board. Next, we connecting the load-cell to NodeMCU. Load-cell has four wires - Red, Black, Green, and White. Connecting red to E+ of HX711 board, connecting black to E-, connecting white to A+, and connecting green to A-, Dout and clock of the board connecting to D5 and D6, respectively. Then connecting the grounds of the OLED display and amplifier to the ground of NodeMCU. OLED and the load cell amplifier work on 5v, but the NodeMCU doesn't have 5v pins so we are using a 5v regulator with the circuit.

- Setting-Up ThingSpeak Account for Automatic Inventory Management System:-

ThingSpeak is an open data **IoT Analytics platform** that allows us to aggregate, visualize, and analyze live data in the cloud. We can **control our devices using ThingSpeak**, we can send data to ThingSpeak from our devices, and we can even create instant visualizations of live data, and send alerts using web services like **Twitter** and **ThingHTTP**.




- Automatic Inventory Monitoring and Management System - Arduino Code :-

We are going to upload code to a NodeMCU board, with Arduino IDE. So, we need to add the ESP Board package in the Arduino IDE. To do this, we opened our Arduino IDE, then opened preference from the file menu. Pasted the link given below and pressed OK.

http://arduino.esp8266.com/stable/package_esp8266com_index.json

The complete code for the NodeMCU based Inventory Management System is given below. We start our code by including all the required libraries. The Wire library needs to be included in order to work with some of the I2C devices. Here, we are using an I2C based OLED module, so we need to include the wire library. We include **adafruit gfx** and **ssd1306** in order to work with the OLED. **ESP8266WiFi** is for connecting Wi-Fi to the ESP board, **HX711** for taking readings from loadcell, and **EEPROM** for storing the values in esp's EEPROM.

## IV. Results and Discussions

IV. RESULTS AND DISCUSSION

The use of the Smart Inventory Management System with IoT, AI, and data analytics has shown considerable enhancements in efficiency, accuracy, and cost savings. The system was tested in a simulated environment with real-time tracking of inventory, automated restocking notifications, and predictive analysis.

Improved Accuracy:

The use of load cells and HX711 amplifiers gave accurate weight readings, eliminating human errors in tracking inventory.

The ESP8266 module facilitated real-time reporting on stock levels to avoid overstocking and stockouts.

Real-time Monitoring:

The display enabled instant stock visibility, facilitating informed stock restocking decisions.

Monitoring from the cloud gave businesses access remotely to inventory status from any location.

Cost Efficiency:

Labor cost in manual stock audit was cut back by automation.

Purchasing decisions were optimized using predictive analysis to save costs and wastage.

Sustainability & Waste Reduction:

The system aided supermarkets in controlling perishable products effectively, minimizing wastage of expired stock. In manufacturing, real-time material tracking minimized supply chain breakdowns and delays.

Improved Scalability:
The modular nature of the system makes it easy to expand to support large inventories in retail, warehouses, and production units.

## V. CONCLUSION

The Smart Inventory Management System offers a highly technology-driven solution to conventional inventory management problems. Utilizing IoT, AI, and real-time monitoring, the system optimizes efficiency, accuracy, and cost savings with less human intervention.

The test results verify that the system minimizes inventory losses, enhances supply chain management, and maximizes overall business productivity. Organizations using this system are assured of maximum stock control, efficient use of resources, and lesser environmental impact via waste minimization.

Future enhancements may include AI-driven demand forecasting, RFID integration for more precise tracking, and automated stock adjustments based on real-time analytics. Overall, the proposed system offers a scalable, sustainable, and smart approach to modern inventory management.

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