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Article

Study of Internet of Things Based Inventory Management System

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A B S T R A C T

In creating ventures and the consistent requests of the item variety, customary Inventory Management model cannot accomplish that, because of its hefty responsibility and low effectiveness. This paper presents another kind of keen Inventory Management System dependent on the IoT and clarifies the standards and design of it. This framework enjoys incredible benefits contrasted with the conventional mode, and we anticipate great possibilities for its turn of events. Stock Management is a vital territory for client care and cost improvement in any assembling arrangement. As organizations turn worldwide and have a great many segments and many distribution centers the stock turns into a bad dream and a ton of time are spend in following stock and guaranteeing right shipments. Customary frameworks of automated arms for stock pick and drop have been founded on premises of checking spaces of the distribution center and following it.

Keywords: Inventory Management System, RFID, Supply Chain Management, IoT, Inventory Optimization

Introduction

New coming of IoT this is set to change as stock articles become more mindful and self-telecom. This paper recommends a methodology of overseeing stock utilizing low energy gadget and does a factual case research on two gatherings of a similar association one preceding the pilot run where conventional standardized identification scanners are utilized to follow stock and other one where the pilot preliminary RFID was utilized. Genuinely the clients are substantially more effective and precise and save part of time and expenses in the short run itself. A RFID tag has an ID that is conveying the data about a particular item. It very well may be joined to any actual surface, including crude materials, completed merchandise, bundles, boxes, beds, and so forth in a modern setting, essentially uninvolved labels are utilized, i.e., those without their own force supply. Such labels are less expensive however require the force from the per user to have the option to send information. With RFID and IoT, stock administrators do not have to invest energy on manual following and revealing. Everything is followed and the information about it is recorded to a major information distribution center consequently. Mechanized resource following and announcing set aside brilliant long periods of working time each month and decreases the likelihood of human mistake.

Internet of Things (IoT)

Internet of Things (IoT) model will associate many smart devices with processing, sensing, and actuating the capabilities which are able for connecting to the Internet. Combining social networking concepts into the IoT has steer to the Social IoT (SIoT) concept which facilitates people and connected devices to communicate, helping information sharing. However, interoperability, security, and privacy issues are a huge challenge for IoT, but these are also permissive factors to create a faithful and interoperable environment. In fact, without solving these factors, the SIoT model will not gain much popularity and all its potential

can be lost. Security factor is prioritized by the deficit of standards specifically designed for devices with limited resources and heterogeneous technologies. Additionally, these devices, due to more vulnerability, serve much more scope for existing cyber threats.

Supply Chain Management (SCM)

A Supply Chain Management (SCM) (Shen, Fang & Zong, 2009) system is a set of software solutions that maintains and supervise the flow of products, data, and finances as a product or service moves from point of origin to its destination via some intermediaries. Supply chain activities enclose all from product development to logistics, including production and manufacturing, sourcing, transportation, inventory and warehouse management, and shipping Figure 1.

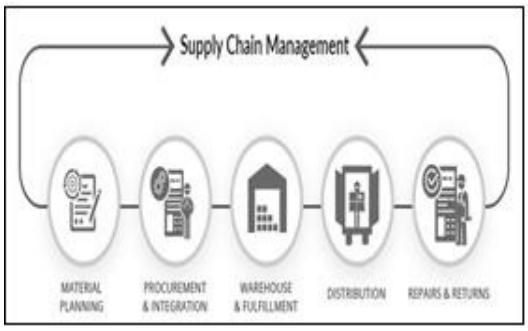

Figure 1.Supply Chain Management

Inventory Management System (IMS)

Inventory management is a complex process, particularly for bigger organizations, but the basics are same indifferent of size or type of the organizations. In inventory management, products are delivered into the acquiring area of a warehouse in the form of raw materials or components and are put into stock areas. In comparison with the bigger organizations with more available physical space, in smaller companies, the products may go directly to the stock area instead of a receiving location, and in case of wholesale distributor, the products may be prepared products rather than raw materials or components.

Distribution of Inventory

Distributed inventory is a concept where in the goods or inventory which is to be given to the retailers & distributors are divided into multiple shipments, each of which is used to fulfill the inventory requirement. Distributed inventory enables the products or goods to reach out to every customers of the region where the products must be sold (refer to Figure 2).

Literature Review

Amount of Inventory

The Stocking of perfect measure of stock is essential. If associations request less, clients will look through better alternatives. On the off chance that associations request immense, quite possibly association will deal with the issue of overloading and at last powerfully sell at leeway costs to stay away from gigantic misfortune. The objective of our exploration paper is to track down the correct degree of stock to keep up fantastic assistance levels. To accomplish this objective, the key is to comprehend the interest and supply it utilizing heaps of information preparing.

Place of Inventory

Has a need of Specific place where inventory can be stored and distributed, such as a storeroom or mobile cart. Locations are listed within a hierarchy, with the inventory group at the top level, followed by the inventory primary location, and the levels of inventory storage areas. For example, an inventory group is in Domjur, the inventory primary location is Jalan Complex, Jaladhulogori (Near to Domjur), the first-level storage area is the warehouse building, and the bottom-level storage area is a bin or shelf.

Record point of Inventory

1. Calculate your lead time demand in days.
2. Calculate your safety stock in days.
3. Sum your lead time demand and your safety stock to determine your Reorder Point.

To understand the mathematics behind our reorder point calculator, let us break this formula down. You will need to know the lead time demand, because that is how long you will have to wait before new stock arrives - you will need to have enough to satisfy your customers while you wait! And you will need to know your safety stock, because that will protect you against any unexpected occurrences. Add your lead time demand to your safety stock. Once your stock levels hit the total, it is time to place a new order to replenish your supply.

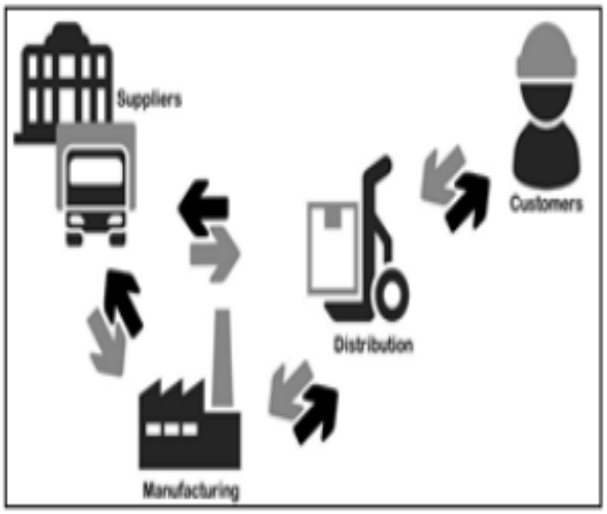

Figure 2.Distribution of Inventory

There are two types of control in distributed inventory systems:

Centralized: In Centralized systems the decision maker at the highest stage decides that, how much inventory should be placed on subsequent stages. It was further suggested that in such type of systems most of the inventory should be allocated to lower stages and few should be kept in higher stages. Inventory should be allowed to keep in higher stages only if carrying cost and load time is very less.

Decentralized: In decentralized frameworks each stage will take the choice all alone there is no such one concentrated chief. One issue with such sort of framework is that there is parcel of approximations and suspicions need to make the stock level decided at each stage.

Method of Stock Control

There are several efficient methods for controlling stock for deciding what, when and how much to order. Apply one or more methods or a mixture of two or more for controlling various types of stock. Depending on different parameters and method of stock controlling that can be classified as follows:

Minimum stock level: Minimum stock level should be identified and should be re-ordered when stock reaches at that level. This is known as the Re- order Level.

Stock review: Regular stock reviews should be conducted. At every review, an order should be placed to return stocks to a prearranged level.

Just in Time (JIT): This method aims to cut down costs by reducing stock to a minimum. Items are dispatched when these are required and used quickly. For avoiding risk of running out of stock suppliers should deliver on demand. This method can be used with other processes to filter the stock control system.

Re-order Lead Time: This method allows for the time between placing an order and receiving it.

Economic Order Quantity (EOQ): It is a standard formula which is used to arrive at a balance between holding too much or too little stock. It is quite a complicated calculation, but to make it simple use stock control software.

Batch Control: This method manages the production of products in batches. You need to make sure that you have the right number of components to cover your needs until the next batch. If your needs are predictable, you may order a fixed quantity of stock every time you place an order, or order at a fixed interval say every week or month. In effect, you are placing a standing order, so you need to keep the quantities and prices under review.

First In, First Out (FIFO): A system to ensure that perishable stock is used efficiently so that it does not deteriorate. Stock is identified by date received and moves on through each stage of production in strict order.

Research Methodology

Inventory Optimization

As customers hustle to deliver or bring back things that do not fit or they do not care for, there is a chance for retailers to move that stock rapidly to another reliable client. However, without the capacity to see returns or trades progressively, that stock turns into a weight on the primary concern. After workers and “store bequest” (physical and online premises) stock is apparently the most significant asset a retailer has. Without it, the retailer cannot exchange. Presently back then, stock is more important than any time in recent memory, however it should be in the perfect spot at the perfect time or the business endures. The network and continuous examination inborn in IoT could be the distinct advantage for retailers’ stock hardships.

Tools for Inventory Optimization: RFID chips can be put on apparel, or even inside it, to give each article of clothing an individual ID. RFID chips are financially savvy and do not need any force source (battery or power); buddy innovation (RFID per users) empowers quick and precise finding. Alongside other IoT-empowered innovation a mix of store-rack sensors, shrewd showcases, advanced sticker prices and high-goal cameras retailers can perceive what is the place where. From the store rack to the back stockroom, focal distribution centers and different stores, they can connect these arrangements of stock information for full perceivability.

Material Requirement Planning: Material requirements planning (MRP) is a system for calculating the materials and components needed to manufacture a product. It consists of three primary steps: taking inventory of the materials and components on hand, identifying which additional ones are needed and then scheduling their production or purchase. MRP is one of the most widely used systems for harnessing computer power to automate the manufacturing process.

RFID System

Radio-Frequency Identification (RFID) is the utilization of radio waves to peruse and catch data put away on a tag appended to an item. A tag can be perused from up to a few feet away and should not be in inside direct view of the per user to be followed. The Warehouse stock administration framework is one of the uses of RFID innovation, on the grounds that RFID can particularly distinguish items or products connected with labels. The RFID per user em-18 used to peruse 125 kHz labels. The RFID per user works at a voltage of 5V. The Reader has two basic goals: at first per user to communicate a transporter signal and the resulting is to get a reaction from any labels nearby the per user. The RFID per user radiates a short-range radio sign which is picked by a RFID tag and the tag is set off on.

A RFID framework is comprised of two sections: a tag or name and a per user. RFID labels or marks are implanted with a transmitter and a beneficiary. The RFID segment on the labels has two sections: a computer chip that stores and cycles data, and a radio wire to get and send a sign. The tag contains the chronic number for one explicit article. To peruse the data encoded on a tag, a two-way radio transmitter-recipient called an investigative specialist or per user emanates a sign to the label utilizing a receiving wire. The tag reacts with the data written in its memory bank. The questioner will at that point send the read results to a RFID PC program. There are two sorts of RFID labels: aloof and battery fueled. An uninvolved RFID label will utilize the investigator's radio wave energy to transfer it put away data back to the examiner. A hitter fueled RFID tag is installed with a little battery that powers the hand-off of data (see figure 3 beneath).

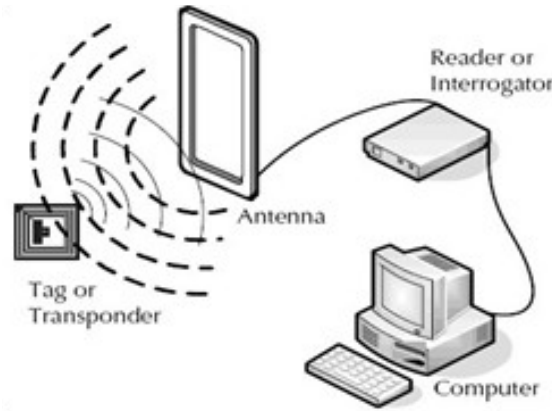

Figure 3.Working Function of RFID

In a retail setting, RFID labels might be connected to pieces of clothing. At the point when a stock partner utilizes a handheld RFID per user to check a rack of pants, the partner can separate between two sets of indistinguishable pants that dependent on the data put away on the RFID tag. Each pair will have its own chronic number. With one pass of the handheld RFID per user, the partner can track down a particular pair, yet they can tell the number of each pair are on the rack and which sets should be supplanted. The partner can gain proficiency with this data without checking every individual thing. RFID frameworks (Huynh et al., 2014) include three fundamental segments: RFID labels, RFID radio wires and RFID per users.

Figure 4.Components of RFID

RFID tags: An RFID tag has an ID carrying the information about a specific object. It can be attached to any physical surface, including raw materials, finished goods, packages, crates, pallets, etc. In an industrial setting, mainly passive tags are used, i.e., those without their own power supply. Such tags are cheaper but require the power from the reader to be able to transmit data.

RFID antennas: An RFID antenna (Kumar & Roy, 2014) catches the waves from the reader to supply energy for tags' operation and relays the radio signal from the tags to the readers.

RFID readers: An RFID reader (Kumar & Roy, 2014), which can be either fixed or handheld, uses radio waves to write to and read from the tags. It can read from the number of tags over distance. The reader catches the IDs that are written in tags' memory banks and transmits them to the cloud, together with the data about the readers' locations and the time of readings.

IoT: The job of IoT in stock administration reduces to transforming the information brought by RFID per users into significant experiences about stock things' area, situations with, and so on, and giving clients a comparing yield. For instance, in view of the information about the stock amount and area, AI a part of IoT-based stock administration arrangement design (Lin, 2012; Gubbi et al., 2013)– can conjecture the measure of crude materials required for the forthcoming creation cycle. The yield of IoT framework gives can have different.

forms: it can send an alert to a user if any individual inventory item is lost, notify the need to replenish materials, etc. Moreover, inventory management solutions based on Industrial IoT can be integrated with other systems, say, ERP – and share data with other enterprise's departments. For instance, since inventory value can be a significant portion of a company's assets, inventory data is crucial for an accounting department to ensure that a company's annual reports and tax returns are accurate (see below figure 5).

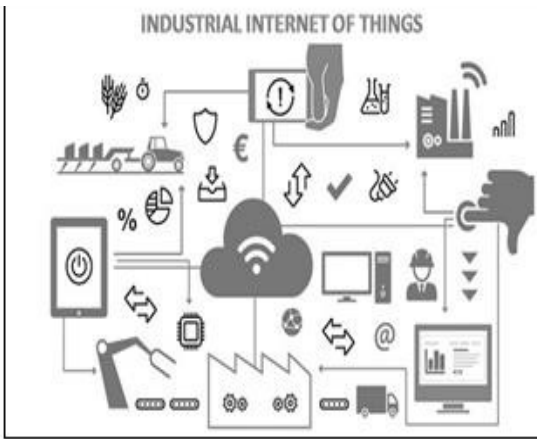

Figure 5.Applications of RFID

Advantages of IoT Based System

IoT-based stock administration establishes a strong framework for the digitalization of the assembling environments and offers both interaction and business benefits, including:

Automation of Inventory Tracking and Reporting

With RFID and IoT, stock chiefs do not have to invest energy on manual following and revealing. Everything is followed and the information about it is recorded to a major information stockroom consequently. Mechanized resource following and announcing set aside to 18 hours of working time each month and lessens the likelihood of human mistake.

Constant visibility into the inventory items' quantity, location, and movements

An IoT-based stock administration arrangement gives producers exact perceivability into the progression of crude materials and parts, work-in-progress and completed merchandise by giving continuous updates about the status, area, and development of the things, so that stock directors see when an individual stock thing enters or leaves an area.

Inventory Optimization

The better inventory managers know their stock, the more likely they are to have the right items in the right place at the right time. With the real-time data about the quantity and the location of the inventory items, manufacturers can lower the amount of inventory on hand while meeting the needs of the customers at the end of the supply chain.

Identifying Bottlenecks in the Operations

With the real-time data about the location and the quantity of the inventory items, manufacturers can reveal bottlenecks in the manufacturing process and pinpoint machines with lower utilization rates. For instance, if part of the inventory tends to pile up in front of a machine, a manufacturer assumes that the machine is underutilized and needs to be seen to.

Lead time Optimization

By providing inventory managers with the data about the amount of available inventory and machine learning-driven demand forecasts, solutions based on IoT allow manufacturers to reduce lead times. Here is an example: a RFID- based inventory management solution allowed Zara to take a garment from design through the manufacturing process to a smart warehouse in just 10 days.

Inventory Management System Based on Iiot and RFID

Inventory management based on IoT and RFID (Ziegler, Graube & Urbas, 2012) works, let us consider an example. Say, among other pharmaceutical equipment, an enterprise produces single-punch tablet presses. The enterprise owns two geographically dispersed factories: one to produce press components, the other to assemble the final unit (Huynh et al., 2014). At the start of the production cycle, the components for, say, die lower punches, get passive RFID tags. Each tag is granted a unique identification number that contains data about every part. The list of tags' IDs (Ziegler, Graube & Urbas, 2012) is saved to a big data warehouse. During the manufacturing process, as the tagged components move from station to station and from shop to shop, the RFID readers (Want, 2006) scan the tags and relay the IDs, the time of the readings, and the data about the location of the readers to the cloud (refer to figure 6).

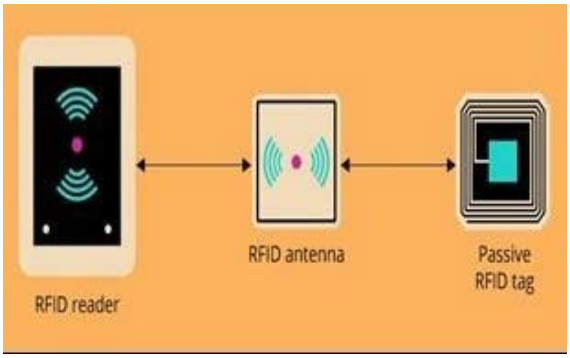

Figure 6.Data Exchanging Procedure of RFID

The cloud investigates the approaching information and recognizes the areas and the situations with the parts. If any of them is feeling the loss of, the cloud pinpoints the missing part, sends a caution to an answer client, and sets the situation with the thing in the stock administration answer for 'missing'. When the area of the part is distinguished, its status is set back to 'in production'. When the production of the die lower punches is finished, they are shipped to the other facility for assembling. They are packed in packages and crates, put on pallets, and placed in vehicles; the vehicles are scanned with a handheld RFID (Wang, 2012) reader before they depart. The employees at the assembly affiliate see that the parts have left the production affiliate. Once the parts arrive at the assembly facility, the vehicles are scanned with handheld readers one more time to make sure no items are lost. As soon as the single- punch tablet presses are assembled, each press receives another tag (the tags from press components can be either kept or removed, depending on the cost-effectiveness of the required operations). As the presses move from department to department, say, from assembly to quality check, the readers installed in the doorways scan the tags attached to the presses to relay the data to the cloud and identify presses' precise location. The presses are tracked all the way till the moment they are shipped to a warehouse. In the warehouse, the reader scans the tags and in case the cloud

detects a missing unit, it sends an alert to an operator. If the IoT-based inventory management solution does not report any missing units, the pallets are forklifted and unloaded. As a result, manufacturers track the inventory from the day the individual components were manufactured to the day the assembled unit arrives at a warehouse and then departs from it to reach end-customers.

Outcome of The System

An IoT-based stock administration and resource following arrangement offers steady perceivability into the stock by giving continuous data brought by RFID labels. It assists with following the exact area of crude materials, work-in-progress and completed merchandise. Accordingly, makers can adjust the measure of close by stock, increment the usage of machines, decrease lead time, and subsequently, stay away from covered up costs bound to the less viable manual techniques.

Results and Discussion

Resultant value stored in the last access details and updated details also available in table format. This table also gives available details of product type as raw or simple. Raw and wet materials are needed to be disbursed soon with comparing to dry products. The table 1 & figure 9 below describes date wise product details. This system also provides date wise stock details.

Table I.Data Processing Details of Stock Table

Sl No	ID Number	Product Type	Stock Room No	Last Date Operated
1	PR001	Raw	SR023	24/01/2019
2	PR002	Raw	SR024	25/12/2018
3	PR003	Raw	SR025	17/03/2019
4	PR004	Raw	SR023	21/4/2018
5	PR005	Simple	SR025	17/11/2018
6	PN005	Simple	SR025	20/02/2019
7	PN006	Simple	SR023	17/09/2019
8	PN007	Simple	SR025	4/8/2019
9	PN008	Simple	SR023	11/3/2019

Figure 7.Product Disburse details of a Day

Following benefits, we can get from this IoT system in which all consideration required to manage resources.

Managing Production

System can simulate the whole process of production enterprises and make production smart management function through the application of IoT (Wang, 2012) technology (refer to figure 10). Production management module include functions of product labeling, product processing and finished product checking; The production plan management module draw up the plan according to receive orders from system; Order management module includes viewing order information and order processing; Production management module of the system can manage product categories of system production; Warehouse management (Huynh et al., 2014) includes inventory management and out of storage management function, the former monitoring products in stock information, the latter shipment handling according to processed orders; Customer management module maintain information of customer; System settings consists of a serial port settings and information settings and set up the software running parameters.

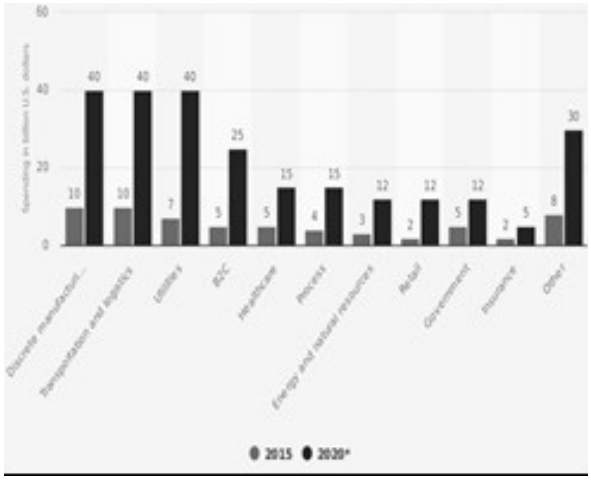

Figure 8.Product Disburse details of a Day

Smart Distribution Process

In mimicked conveyance connect, dispersion focus as per the store request create stock out and appropriation list, the previous is given Warehouse and later is given vehicle area. After out of capacity the framework consequently refreshed stock data; After the fruition of out of capacity, the merchandise is pressing in the wake of passing arranging activities; In the pressing, a specific number of completed products bundle boxes, and marking in each case. In the vehicle joins, box as a unit will be overseen. Transport division is shipment readiness after getting circulation list, first it conveys vehicles, drivers for appropriation list and improve the dispersion list data; simultaneously, prior to stacking the quantity of box is conveyed in a bed, RFID

electronic mark is appended to every bed and bed ID related with the vehicle ID. Type of the solitary vehicles and the lone driver with the relating bed are checked in the long run. Savvy racks in the stockroom will ongoing screen the stock data refreshed, if the stock number is not exactly a specific reach, dispersion focus create produce renewal request to illuminate the creation undertaking for creation and handling exercises. Keen racks will acknowledge programmed fast stock actual tally. Furthermore, educate the EPCIS (EPC Information Services) worker out of capacity, warehousing, and stock of product data. This framework complete keen stock administration work by receiving the keen racks.

Process of Intelligence Transportation

Platform can simulate the whole process of transportation and realize intelligent transportation management functions through the application of IOT technology. In road link (Ibrahim & Ibrahim, 2010), the drivers of transportation get distribution list and complete the preparation activities to automatic complete the vehicle and the driver matching through the RFID technology, and start a series of executable program of vehicle like opening the GPS system automatically, show distribution tasks and route, etc. In road, vehicle real-time send in road information to the data center including vehicle speed and position information, etc. When abnormal situation has happened, such as speeding, deviating from the transport routes, system gives an alarm, starts vehicle anti-theft system, and report vehicle position information to the data center server.

Conclusion

This paper built a supply chain simulation platform system based on IOT technology, analyzed the application of key technology in the system, and designed smart shelves subsystem, smart shopping cart subsystem and so on. The operation process is simulated according to the particularity of the supply chain enterprise. The system can provide a full range of search service for customers through the WEB service and realize the visualization management of the whole process of mobile commerce so the user can trace the whole process of goods for safety and achieve more efficient supply chain management. Following chart shows the acceptance of IoT in different future projects in respect of U.S. billion dollars.

The developed Warehouse inventory management system is very efficient, it can perform dynamic data updating and Real Time search operations from the database with the help of a web server. Thus, the implementation of RFID System of this proposed methodology is not bounded to prototype or laboratory setup but can also work efficiently in Real world application. The total implementation cost of the developed warehouse inventory management system is exceptionally low compared with the present existing models in the marketplace. With the implementation of user- friendly user interface, the users can easily spot the tracked product in the Warehouse without much effort. In future, this innovation can be used in several areas in different applications and many enhancements can be done so that it can be made available to all the sectors.

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