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Internet of Things driven Inventory Management for the Retail Pharmacies

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Abstract: ***The technological transformation has resulted in a massive change in businesses around the world. Inventory management, which an essential part of every business, has also been impacted a lot. Inventory management is a subset of the broader Supply Chain Management (SCM) and mainly aims at achieving customer demands by storing products and managing inventory levels. Internet of Things (IoT) has become a hot topic these days, and the paper's fundamental objective is to examine the importance of IoT and how can it be beneficial in managing the inventory of the retail, pharmaceutical sector. A brief analysis of the existing inventory management practices carried out by the retail pharmacies in the Cachar district of Assam was conducted to analyze the present scenario and the problems encountered by the pharmacists in managing their stocks. The paper then discusses the potential benefits of adopting a smart inventory management system for controlling their inventory levels so that they prevent losing customers due to a shortage of medicines. A conceptual framework for implementing an IoT based inventory management in the retail pharmacies has been proposed which can prove to be beneficial in providing real-time transparency and give practical guidelines for the retail pharmacies that are using the traditional approaches.***

Keywords**: Internet of Things, Inventory Management, Retail Pharmacies, RFID.***

I. INTRODUCTION

Internet of Things (IoT) has become a burning topic launched not only in the business world but also in our everyday life scenes. Any device which is being called "smart" is IoT. It is both "the future" and "now". Internet of Things (IoT), with its inception, is revolutionizing many industries, including inventory management. IoT is the global network of small, robust sensors and interconnected "things" that allows physical objects to connect, interact and share data or with a central database through the Internet. These can include any device such as televisions, washing machines, light, fans, etc. The ever-changing business environments impose new requirements which are becoming a challenging task, especially in inventory management, where there are several stakeholders. Inventory is a critical link in the supply chain management, and every company is looking for ways to keep up with the customer demands being correctly served. The goal of inventory management is to reduce costs and improve operational efficiencies in order to fulfil customer demands. For doing this, retail pharmacies need complete visibility into their existing inventory levels in order to maintain ideal supply levels and be able to track inventory stores, orders generated, inventory receiving all in real-time. For keeping up with the demand and supply, it is essential to use IoT properly. The need of the hour is real-time visibility into pharmacy operations without which it would be difficult to track products along with wastage of storage space and also, the temperature variations that could be an issue while handling the medicines. IoT-driven smart inventory having sensors and readers would increase the visibility of operations in the pharmacies and present the data seamlessly to the pharmacists by reporting data about the products and their condition so that they can take a supported decision.

The geographical scope of the research is the Cachar district of the Barak Valley region in Assam, India.

The prime objective of this survey is to assess the current inventory management practices carried out at the retail pharmacies of the Cachar district and to understand how the integration of IoT within their inventory management can improve their practices. Lastly, a conceptual framework is provided for implementation in real-life scenario.

II. REVIEW OF LITERATURE

Inventory management is considered as a significant issue in every organization. For investigating in such a case, [2] proposes an optimization of inventory model in which items deteriorate in-stock conditions where a multi-objective mathematical model is developed for the location-distribution problem based on a real-life case study for a municipal district in Tehran. [2]

One of the main problems of pharmaceutical distribution companies is to control inventory levels in order to prevent costs of excessive inventory and to prevent going out-of-stock due to drug shortage [8].

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In pharmacy operations, inventory is referred to as the stock of pharmaceutical products stocked to meet future demands. Efficient inventory management aims at reducing the inventory costs while maintaining an adequate stock of products to meet the customer needs such that they do not go out-of-stock and lose sales due to the unavailability of medicines. It may also adversely affect a patient's wellbeing in a hospital setting if the prescribed medicine is a life saving one [1].

The term IoT was first used by Kevin Ashton when he was giving a presentation at Procter & Gamble in 1999. Within just ten years, its popularity increased. He said that almost everything depended on human beings for information, but people are busy with limited time, attention and accuracy, all of which means they are not very good at capturing data about things in the real world. Computers should be empowered with their means of collecting information, so they can see, hear and smell the world, all by themselves in its random glory. The Internet of Things has the potential to change the world, just as the Internet did or maybe even more [6].

Greater and greater attention is paid to the Internet of Things technology emerging as an information network for the application in the field of logistics, tracking of goods, information traceability and by providing advanced technical support. [4] in their research build a manufacturing inventory management model based on Internet of Things technology where they explain the design and implementation of the model. Finally, the authors proposed measures to promote the manufacturing inventory management model based on Internet of Things technology.

Based on the literature review, it has become evident that very few works have been done on inventory management in Cachar district, but no work has been done on IoT enabled inventory management in the area.

III. NEED FOR THE STUDY

Effective inventory management is vital for any business because of any mistake in the inventory results in the most significant expense if not managed properly. Carrying too little inventory or too much inventory in retail pharmacies can even be a matter of life and death where a patient's safety is at line. Thus it is necessary for the people of the retail pharmacies to understand how the integration of IoT in inventory management can help in running their business more effectively, resulting in better customer satisfaction.

An inventory consists of an innumerable number of products which is why it is imperative to utilize it optimally. IoT enabled inventory management guarantees a practical impact as it can be used to monitor several processes in the retail pharmacies in real-time and can eliminate manual interventions. It can make everything connected and, therefore, allow the analysis of a large amount of data acquired by these connections and transform them into insights to support decisions and improve overall performance [7].

Traditional inventory management systems have become less efficient and unsuitable for today's increasing market requirements. Current inventory management systems do not manage inventory exhaustively and smartly. They do not have a way to track goods within the warehouse, bogie, truck, other vehicles, and premises. These kinds of inventory systems lose sometime during movements and hence need improvements to optimize timings.

If proper inventory management practices are not adopted, it impacts costs on several levels: lost sales, wastages, procurement costs, carrying costs, holding costs, etc. An effective ideal inventory management system in the retail pharmacies would be by integrating IoT with its inventory which maintains an automated, unceasing inventory and is linked to the point of sale (POS) system through a centralized database system that allows for the maintenance of a real-time systemic inventory.

In the past years, traditional methods that were used to design complex systems are limited in human operation. Human operation mechanisms and the complex system involving relationships may be nonaligned underlying IoT environments. The integrated supply chain can be controlled transforming information system into an autonomous and dynamic network [3]. The complexity efficacies can autonomously react to a wide range of different situations in order to minimize human intervention [5]. The human way of the thinking process is used to illustrate the autonomous mechanism for relationship management in IoT-enabled information systems [9].

Radio Frequency Identification (RFID) can be used for controlling inventory, stock security, quality management, etc. It allows a business to identify individual products and components, and to track them throughout the supply chain from production to the point-of-sale. There are three main parts of RFID viz. RFID tags, RFID antennas, and RFID readers.

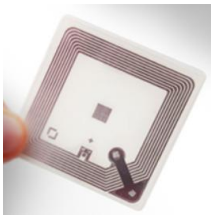


Fig 1 (a): RFID Tag

Fig 1 (b): RFID Antenna

Fig 1 (c): RFID Reader

Source: Google images

RFID is a technology that utilises radio waves amidst a tag and a reader for transmission. The tag usually consists of a microchip connected to an antenna.

The reader can read data from and write data on the tag. The information recorded by the reader is collected and processed by specialised computer software. Readers can be placed in different locations within a factory or warehouse to show when and where the goods are moving.

RFID chips can be placed on medicines or the cartoons outside it to give each medicine or cartoons an individual ID. The RFID readers enable fast and accurate locating of the items. Along with these, RFID includes shelf sensors, digital price tags, high-resolution cameras and smart displays which enable retailers to see the exact location of each item.

RFID tagging offers several advantages for stock control over other methods such as barcodes:

1. Several tags can be read at once, which helps in checking an entire batch of products simultaneously unlike barcode where tags can be read manually only one at a time.
2. Tags are given unique identification codes so that those individual products can be tracked.
3. Tags can read, write, modify and update, unlike barcodes which can only be read.
4. There is very less human interference in the practice, which helps in saving much time.

Technology is at its dawn, and soon new entrepreneurs are going to explore this field more by operating through both offline and online in the pharmaceutical sector. To achieve success in this era of omnichannel, transparency, accuracy and real-time operations in inventory management systems are essential to ensure uninterrupted sales all the time. Customers are always busy and thus prefer getting everything served at their door, so ordering medicines online is a more convenient option. US retail giants Walmart and Kroger use IoT in their operations. Walmart has developed robots for improving their operational efficiencies to provide better customer services, while Kroger uses sensors in containers to track moving products. [10].

A very sound application of IoT in pharmaceutical industries is the use of dedicated mobile apps and wearable devices. Patients are traditionally monitored based on subjective assessments. Many patients do not even understand they are suffering from any medical condition or show visible symptoms and thus, may be unable to alert anyone at the time of crisis. That is where IoT comes in [11].

IV. RESEARCH METHODOLOGY AND DATA

The present research is exploratory in nature, and a quantitative method of data collection is being used. The study analyzes the responses of the retail pharmacies of the Cachar district of Assam and attempts to find out the problems arising in the process.

The data collected is both primary and secondary in nature. The primary data is collected through a structured questionnaire comprising of closed-ended, multiple-choice questions, and the secondary data is collected from online through various journals, articles, etc.

For the survey purpose, systematic random sampling is being used as the sampling method, and the sample size of the study is considered as 80. The total population of the retail pharmacies of the Cachar region of Assam is 800. Thus, a sample of 80 retail pharmacies is selected by moving through the population and identifying every 10th pharmacy after the first randomly selected pharmacy.

For analysis, data are tabulated in a simplified manner and calculated with the help of percentage, Chi-square ($\chi 2$) test and descriptive statistics to find out the desired results.

V. RESULTS AND DISCUSSIONS

A survey is being conducted to analyze the present scenario of inventory management practiced by the retail pharmacies. For this, a structured questionnaire consisting of 11 questions is being used, which fulfils the very need criteria of the objectives of the study. A total of 80 samples are being taken from the Cachar district of Assam for the survey.

A. Present scenario of Inventory Management in the retail pharmacies at Cachar district

- On being asked to what extent do the pharmacists think that proper management of their medicines is essential for their business, 85% strongly agreed to its importance, 10% agreed to it and 5% were neutral. None of the respondents said that they think proper inventory management practices are not essential for their business. The mean of the observation is 4.8, with a standard deviation of 0.51. So, by analysing the data, it can be interpreted that the maximum of the respondents think proper inventory management practices are essential to a great extent for their business.
- Only 21% of the respondents said they use an inventory management system, whereas the rest of the 79% do not use any inventory management system and still rely on Excel or paper-based methods.
- Out of the 21% who use an inventory management system to keep track of records, none said they use any IoT based inventory management system.
- Most of the retail pharmacies maintain safety stock i.e., 76% whereas 26% of them do not.

- Maximum of the respondents i.e., 73% keep more than 20 suppliers on hand, 20% keep 10-20 suppliers and 7% keep 5-10 suppliers. None of them keeps five or less than five suppliers.
- 68% of the respondents keep track of their inventory through manual checking, 20% follow just-in-time strategy i.e., they order the medicines as and when their stock gets over and do not maintain any safety stock, 9% follow FIFO, and 3% of the respondents use forecasting to manage their inventory.
- Major challenges faced in terms of inventory management are failure to keep track of stock (54%), followed by excess inventory (40%) where the medicine do not get sold and add to unnecessary inventory costs. 3% responded with low item turnover and other reasons each.
- The reason for going out-of-stock (OOS) or lost sales is mainly due to failure to keep track of stock (59%). Manual checking is very inefficient as a result of which the pharmacists find difficulties in keeping proper track of their stocks. 27% said they go OOS because of failure to order in a timely manner which is also a consequence of having inaccurate data. 10% responded with not having enough working capital to reorder, and 4% responded with poor communication with the supplier.
- 90% of the respondents said they face wastages due to expiration of the medicines, 6% said due to damaged or defective medicines and 2% said due to spilling of the medicines. Remaining 2% said other reasons such as natural calamities, etc.
- Pearson Correlation Coefficient analysis is carried out to analyze the effect of stock-outs and wastages on the sale of medicines.

Table- I: Correlation test (Pearson Correlation Coefficient)

	Stock-outs	**Wastages**	**Sales**
Stock-outs	1		
Wastages	0.200961057	1	
Sales	-0.026993656	-0.051834341	1

Source: Data collected from primary data through field survey

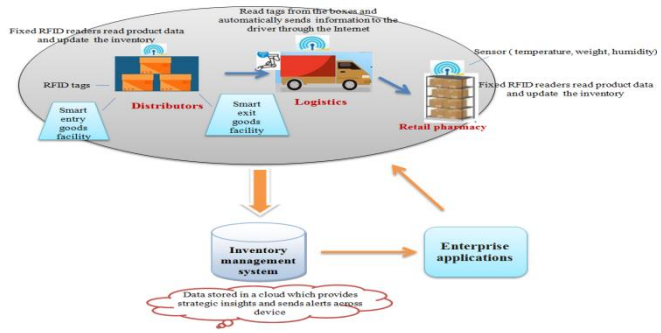
Table I shows that there is a significant relation between stock-outs and wastages but has a weak strength. Both stock-outs and wastages shows negative relationships i.e., both of them are inversely proportional to sales. Thus, increase in stock-outs and wastages causes a decline in the sales.

The product stock-outs are a big challenge for the retail pharmacies. Globally, the average retail shortage is 8.3 percent, which means that for every 20 items on a buyer's list, it is likely that at least three are out of stock (Mu Sigma, 2015). This problem and the associated costs for the retail pharmacies are particularly serious as medicines have a short life span.

B. Conceptual framework of implementing IoT in Inventory Management of retail pharmacies

A framework is proposed to implement IoT integrated into the inventory management of the retail pharmacies, as shown in figure 1. The framework is proposed to automatically place the orders for restocking whenever a particular category of medicines get out-of-stock or any medicine is nearing its expiry date.

In retail pharmacies, the medicines are obtained from distributors/wholesalers or sometimes the manufacturing companies directly. The medicines that are arranged in boxes will consist of RFID tags attached to them. As soon as these pass through the smart entry/exit goods facility, the RFID reader attached to the gate of the warehouse of the distributors or the manufacturing companies, records data about items listed on the tags attached to them furnishing real-time tracking of the items and visibility of inventory levels thereby preventing stock-outs. The readers that are attached to the transporting device read data that lists the product type, location, weight, temperature, expiry date, etc. and share this data with the driver which gets stored in the cloud and received through the Internet. Thus the pharmacists can in real-time track their incoming orders. The medicines received are stacked on the shelves of the retail pharmacies, which consist of sensors. These sensors give confirmation to the driver that the product has been arranged on the shelves and sends notifications to the distributors or manufacturers that the medicines got delivered. The sensors continuously monitor the temperature, weight, and humidity of the medicines in order to ensure quality and optimum inventory levels. The data that are recorded from the sensors and readers are sent to the inventory management system (IMS) which is a cloud-based system that processes, manages, modifies and updates the data and converts it into useful information. Then this information is sent through the enterprise applications to the users as alerts for taking necessary strategic actions. The sensors on the shelves continuously keep on tracking the weight of the bottles, and when the stock reaches down to a particular level, an order for restocking is automatically sent to the manufacturer directly or through the distributor. Many medicines are required to be kept at a particular temperature. The sensors keep on monitoring these too and also notifies whenever any medicine is nearing its expiry date. For efficient inventory management, it is very essential to have a transparent supply chain management between the suppliers, manufacturers, distributors, retailers, and customers.



Source: Compiled by the researcher

Fig. 1: Proposed framework of implementing IoT in inventory management of retail pharmacies

The proposed conceptual framework of IoT integrated inventory management system requires less human intervention which automatically increases efficiency; saving time and hence saving money. Manually checking the inventory can take a much longer time, but with a smart inventory management system, the same process can be done within a matter of a few seconds.

VI. CONCLUSIONS AND FUTURE RESEARCH

Overall, this research paper provides a view of the current status of inventory management practices in retail pharmacies. This research also identifies the benefits of integrating IoT in Inventory Management practices. Besides, a framework for implementing IoT in inventory management systems is proposed that is expected to be beneficial for the retail pharmacies and improve their overall performance.

Smart inventory management plays a significant role in retail pharmacies from both operational and financial perspectives. Thus, it is very crucial to adopt a smart inventory management system as it is one of the critical investments in any business, especially where the patient's safety is on the line. Most of the pharmacists go out-of-stock mainly due to inaccurate data. A smart inventory management system makes everything much precise, accurate and more accessible by automating processes connected through a centralized database system.

While this study provides valuable insights about why the retail pharmacies should use IoT for effective management of their inventory, the study provides no account of the real-world effectiveness of the technology which leaves scope for further research. There are many scopes for this framework to be implemented for future researches on the real environment and compare the positive effects outlined in this proposal with the actual results.

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