

An Efficient way of Supply chain management of Human Insulin with Application of IoT & RFID

Sonali Suchismita Dash

Assistant Professor

Metas Adventist College

Surat, Gujarat, India.

Abstract

Medicine is one of the essential and first-aid preferred for curing of diseases. All of us have the fundamental right on the good quality of drugs manufactured for human use. We take it granted that the quality control system of each manufacturer is working properly and there is no any sub-standard product is entering the market. However, it might not always be the case. Here the study is to be done on Human Insulin, a synthetic insulin hormone prepared in the laboratory to cure patients with diabetes. Today, around 100 million people in the world need insulin, including all people living with type 1 diabetes and between 10-25 percent of people with type 2 diabetes. There are certain rules and conditions to be followed for storage of the insulin vials, and if it is not followed properly then the effectiveness of the medicine deteriorates.

Here the study ensures rigid quality management of the prepared drug Human Insulin vials from the floor to the store by the application of IoTs and RFID technology. It will study the entire process, and after observing each stages of the supply chain network and taking interviews with various stakeholders, the problem points can be identified. Potential solutions to the problems can be found out based on literature studies of the above-mentioned technologies which further leads to the conclusion and recommendations of the study.

Keywords: Supply chain, IoTs, RFID, Human Insulin vials, WSN.

1. Introduction

Health is the most important social and economic asset than any other thing in this world. Being healthy is the foundation of any other development in life. Medicines are among the most effective ways to prevent illness and to lead a healthy life. In this paper, the study is to discuss the medicine used for the treatment of diabetes mellitus. Diabetes mellitus commonly known as diabetes is a lifelong chronic disease which is caused by the deficiency in the production of Insulin from the pancreas. According to latest data globally 422 million people are affected with diabetes (WHO, 2016) and 100 million people are in need of Insulin. Human insulin is synthetic insulin prepared in the laboratory, which is injected from outside to the patient's blood to control the blood glucose level. Hence to get maximum benefit from the use of this, proper quality should be maintained during the preparation and distribution of the drug; otherwise, it may lead to costliest health hazards or in some cases loss of life. So the authenticity and quality of the drug should be maintained throughout. This can be checked with the help of recent development in technology. Here the thesis will study the problems, analyze it with the stake holders involved in the process, propose solutions for them by implementations of IoTs (Internet of Things) to the process of manufacturing and distribution of human insulin.

1.1 Human Insulin:

Insulin is a peptide hormone released by the beta cells of the pancreas. It is used to control the blood glucose level of the human body. If the beta cells are destroyed due to some autoimmune reactions than the pancreatic islets cannot able to prepare the required amount of insulin to control the blood sugar, and the patient may suffer from Diabetes. In this case to control the blood glucose level Insulin prepared in the laboratory is injected from outside. This synthetic insulin called Human Insulin is prepared in the laboratory by recombinant DNA technology is used to mimic the insulin in human.

1.1.1 Storage Guidelines: Here the prepared insulin is sealed by plastic or glass containers. The unopened vials of Insulin should then stored in the warehouse at a temperature of 2 to 8 degree Celsius and protected from direct sunlight and heat. Never freeze the insulin vials. This is then distributed to Whole-sellers, stockiest and pharmacies with the help of cold chain logistic distribution process.

As Insulin is very sensitive to sunlight, indoor lights, and to extremely hot or cold temperature, if these above conditions are not maintained then the medicine will not work well to lower your blood sugar. Here the study analyzes the Storage, handling and distribution part of human insulin as the temperature control is concerned, the potential errors that may occur and the solutions for the same by implementation of IoT on the insulin vial.

1.2 IoT (Internet of Things):

Information technology (IT) has been, and continues to be, an essential enabler for effective supply chain management (SCM) (Ross 2016).IT is able to achieve this because of its capacity to integrate the external suppliers and customers with the internal business processes. IoT (Internet of Things) is one of the latest invention of IT, Which is the network of devices that can connect, interact and exchange data. It involves extending internet connectivity beyond standard devices like smart phones, laptops, desktops, and tablets to any range of everyday objects. Embedded with technologies these devices can easily connect with the internet and exchange data, communicate and interact over the internet.

By the use of IoT the product can be tracked from floor to store with the help of RFID and GPS sensors. At any point in time, granular data can be obtained by the sensors like temperature, how long it has spent on cargo and many more. The type of data gained from IoT can help companies to have a tighter grip on quality control, on-time deliveries, and product forecasting.

IoT is a global network infrastructure, which links the physical and virtual objects with the internet cloud. The IoT technology refer a network which follows conventional protocol and links the objects via internet to transfer the real time data for the purpose of realizing intelligent detection of objects, namely object current location/status/temperature conditions, tracking, monitoring and management, with the help of RFID tags, sensor devices, actuators and positioning devices. By taking this as an advantage, IoT is a unique platform to monitor the real time status of the pharmaceutical goods in the value chain. Hence this paper proposes an intelligent predictive system for the Pharmaceutical logistics by integrating IoT and tracking technologies.

IoT technology As in Xu, He, and Li (2014), a typical IoT network includes four main essential layers:

- (1) A sensing layer that integrates different types of 'things' like RFID tags, sensors, actuators;
- (2) A networking layer that supports information transfer through wired or wireless network;
- (3) A service layer that integrates services and applications through a middleware technology;
- (4) An interface layer to display information to the user and that allows interaction with the system.

1.3 RFID (Radiofrequency Identification Device):

Radio frequency identification, or RFID, is a generic term for technologies that use radio-waves to automatically identify people or objects. There are several methods of identification, but the most common is to store a serial number that identifies a person or object, and other information, on a microchip that is attached to an antenna (the chip and the antenna together are called an RFID transponder or an RFID tag). The antenna enables the chip to transmit the identification information to a reader. The reader converts the radio waves reflected back from the RFID tag into digital information that can then be passed on to computers that can make use of it. RFID tags are used in many industries. For example, an RFID tag attached to an automobile during production can be used to track its progress through the assembly line; RFID-tagged pharmaceuticals can be tracked through warehouses; and implanting RFID microchips in livestock and pets enables positive identification of animals.

2. Problem Statements

The current practices followed for distribution of human insulin vials are limited in regard to viewing real-time cargo conditions. The formulation of follow-up plans is affected if accidents occur...The distribution process of Insulin follows a cold chain logistic. It has to be kept, to be maintained and to be stored in 2 to 8 degree Celsius temperature. Not being able to withstand with this minimum temperature standard can harm the effectiveness of the drug. There is lack of effective storage guidance in handling the external conditions and factors in the warehouses.

In today's scenario when a customer buys a drug from the pharmacy, he does not know from where and in what conditions the drug has come. Tracking of the drug throughout the distribution chain by the consumer with a unique serial number or a barcode or QR code is a good defense against criminal infiltration. In current practice of distribution of vials as data is not available in real-time, the systems are susceptible to fraud and manipulation, which ultimately lower the efficiency of the drug.

3. Objectives of Study

- **Transparency:** To enhanced transparency by recording the drug's journey throughout the supply chain from its raw materials. Monitoring supply chain processes and events will identify the problems and issues pro-actively, which in turn enhance the efficiency of the supply chain.
- **Customer Awareness:** To increase customer awareness and provide the customer with the ability to evaluate the drug, the manufacturer, the carrier, etc. before making a purchase decision. This will enhance the customer's faith in the drug and the company.
- **Tracking:** Linking of the physical drug with the sensors or electronic seals can provide the actual data about the condition of the product at each stage of the supply chain.

4. Research Methodology

The purpose of this study is to outline whether the use of IoT along with RFID technology can enhance the efficiency of the distribution process of human insulin. Thus the data to be collected for the study should be of interpretive character. So here the study should follow the strategy of Qualitative research.

4.1 Research Methodology and Design:

4.1.1 Data collection:

For this study, the researcher surveyed the insulin products sold in select pharmacies in Gujarat and interviewed customers, pharmacies and wholesalers, warehouse personals.

4.1.2 Primary data:

This data can be collected in by taking interviews and discussions with stakeholders and industry experts. The detailed study of each step in the supply chain network is necessary to find out the exact focus point.

Here the study involves both open ended and closed-ended questions. The data collection was done through self-administered questionnaire. This guarantee the accuracy of responses from respondents to enhance reliability of research results.

Purposive and stratified samplings were used for the sample selection. Purposive sampling is a non probability sampling technique where sampling is done with a purpose in mind. Here the researcher has used the purposive sampling to reach to the target population which are more readily accessible.

4.1.3 Secondary data: Information has been collected from Pharmaceutical reports, online newspapers and websites.

4.1.4 Sample size: 50 customers, 50 retail vendors, 10 distributors, 2 regional warehouses, 1 central warehouse

4.1.5 Sampling frame: Gujarat, India

Major Variables of the study: The external factors and conditions affecting the insulin vials from the manufacturer to the customers.

5. Research Analysis

After analyzing the entire supply chain process of movement of insulin vials from the manufacturer to the customer the major challenges are

1. The first element is the diversity of supply. For insulin, the global market is dominated by three multinational companies which control 96.0% of its volume. The remainder of the market is shared by 42 other insulin manufacturers in 17 countries. As India is a large country the pharmaceutical industry is fragmented and the companies are more focus to fulfill the demand at a minimum cost, so as to maximize their gain, hence less interested towards the customer side of maintaining the 100% efficiency of the product.



Fig: India's insulin market

Source : business-standard.com

Number of manufacturing sites of Novonordisk in India – 0

Number of manufacturing sites of Biocon in India - 1

Number of manufacturing sites of Eli Lilly in India – 0

Number of manufacturing sites of Sanofi in India - 1

Hence from the above data it is clear that though India has a very large insulin market size, still the number of manufacturing sites of human insulin is very less. So it is very clear from the above analysis it takes a large transit time of human insulin vials from the manufacturer to the consumer.

2. During transit by air the vial containers have to be opened and go through X-ray scanning process. This process needs for human intervention and manual handling of the vials.
3. Here there is a long distance of trucking to and from the airport and warehouse of the vials. Trucks can be stuck for hours in traffics and also may stick for days because of some machine breakdown.
4. The retailers while ordering the vials from the stockiest to their stores, they are not at all maintaining the temperature conditions because of lack of awareness of the delivery personals.

Here the researcher has surveyed 50 retail vendors, and obtained the following result.

Maintaining temperature conditions	14
Not maintaining temperature condition	26

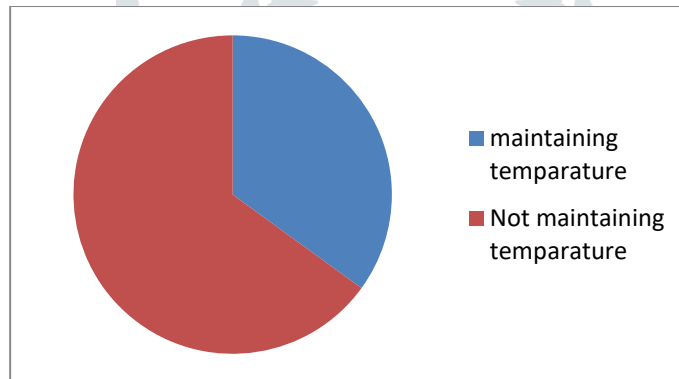


Fig: Maintenance of temperature conditions

As non-maintenance of proper temperature conditions lowers the effectiveness of the insulin protein, This is a very serious concern need to be taken care of.

5. Because of limited availability of cold storage facilities and high temperature of our country, the effectiveness of the vials may decrease.
6. There is a lack of quality orientation and training among the people involved in the supply chain process.

6. Recommendations

As per the customer perspectives they want the purchased drug to meet the quality standard and must be safe for use. With IoT devices and the RFID sensors all the stakeholders involve in the supply chain process can track the shipment from the manufacturer to the final delivery location including real time information on product condition and temperature along the way.

6.1 Implementation of RFID along with IoT to the Insulin Vial:

Few necessary components are required to enable communication between devices and objects while working with Internet of Things. An Auto-ID technology i.e. an RFID tag is required for unique identification of the object. RFID tag allows the object to wirelessly communicate certain types of information, which gives the ability to monitor real time data on status of the object. Here the sensor present in the RFID tag will capture fluctuations in the surrounding temperature, changes in quantity, or other types of information. By the help of sensors, RFID tags, and IoTs the persons see in real-time the exact location of the object inside the warehouse, the point of origin, days until expiration, and surrounding temperature conditions.

Two-layer network architecture is considered, first layer is an asymmetric tag reader link (RFID). RFID tag is attached with the insulin vial during the transportation. Now each and every product has a unique identification IP address. This IP address is connected to the second layer of the network architecture. The second layer is a wireless sensor network (WSN). WSN is connected through the internet via mobile, Wi-Fi etc which gives the real time information about the product.

The first layer is radio frequency identifications (RFID) and second is wireless sensor network (WSN) layer. By adapting the proposed system the pharmaceutical company can easily track and monitor the goods during transportation. This system will avoid the physical damages, moisture, humidity and counterfeit drugs. The future research is focused on field testing of the proposed methodology and collects a live data for data analysis.

The stake holders can get access to detailed shipment tracking information on one single platform including:

- When the shipment departed and arrived
- Exact real-time location
- Exceptions regarding product temperature or condition
- Expected delays

6.1.1 Major advantages

- Supply chain visibility
- Operational efficiency
- Better customer service
- Better inventory management
- Loss management

6.1.2 Challenges in Implementation:

- High Capital cost
- Lack of in-house experts to implement RFID
- Uncertainty about physical security of data storage sites.
- Privacy issues and government regulations

7. Conclusion

IoT devices and sensors will take the Human insulin industry to the next level.

These devices enable all the stakeholders involve in Human insulin supply chain to remotely manage, control and track the insulin vials to minimize errors.

Also, by providing real-time information quality of insulin vials can be improved.

Internet of Things is a reality in today's era of digitization and, therefore, it deems fit that Pharma companies adopt it at the earliest. Though IoT is still in its nascent stages of development and adoption across industries, it is imperative for manufacturers of human insulin to include IoT as part of their strategic focus. This increase the faith of customers on the product they purchase, which increase their return on investments.

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