SMART WAREHOUSE DESIGN BASED ON REMOTE TECHNOLOGY


ITESM (MEXICO)

Abstract

In this paper different tools, strategies and techniques to support the use of RFID technology are showed to identify the specifications of each product of an SME, a new and effective method of accounting is proposed for their daily production and the movement of this production. In addition, an original platform is designed easy to use that allows effective access to the existing inventories. This platform can be viewed from a computer in real time and remotely without having to enter records manually. The goal is to demonstrate how an SME that has no record control or warehouse space established can design its own intelligent storage system in an automated way with less intervention. This last thing will represent a change in cost, space, time, and efficiency to prevent losses, translated into a better decision making that benefits them both immediately and in long term. This will provide a better overview of how the company works, providing an effectively customer service. It is very important to mention that with an adequate management and control of inventories, the costs of having merchandise in store can be minimized, considering that these are of utmost importance for companies engaged in production in the industrial sector. Another important result of this work is the development and the proposal of a packaging based on coconut fiber with a strength and hardness of a carton for the storage and transport of the products inside and outside the plant. With this innovative packaging, a container that does not damage the environment in an ecological way in addition to reducing the current costs of packaging was sought.

Keywords: RFID, inventories, real-time, remote, coconut fiber, packaging.

1 INTRODUCTION

The work focused on a Mexican SME company dedicated to the design, manufacture and decoration of articles of recycled and artisan blown glass, with a variety of more 500 different products, which provide large sales companies throughout the Mexican Republic and destinations outside the country. At the moment, the company has around 100 employees who are in charge from the production of the articles until their sale. The production of hand blown glass products requires an elaborate production process, in addition to considering the specific requests of each client to plan the production of the day. Another important step is to order the production along with its packaging when the product reaches the end of the production line and goes to the warehouse. This last stage is when the conflict that the company has studied begins: it is the problem of the effective management of its inventory.

The main problem presented is the lack of control and mismanagement of inventories. "Inventory" can be defined as the existence of any article, product or resource used in an organization; these can be raw material, product in process and finished product. When representing an asset, having inventory generates a cost, which in the clear majority of the time, is very high. That is why the correct control of inventories is one of the greatest challenges that many companies face today day by day and among them the selected SME. By having an order and optimal registration to have a control of inputs and outputs of finished products fresh out of the inspection and packaging area that are directed to the warehouse, will lead to a better consensus and management of current stocks. Another result is the remarkable improvement of the efficiency in the search of products of store and customer satisfaction by the order. Nowadays, the lack of a system of controlled recording of inputs and outputs for daily production leaves losses in inventory and waste of time, overproduction, major storage and transportation problems. Unfortunately, this situation occurs very often in different small and medium-sized companies dedicated to the production and sale of own articles.

The general objective of this work is to design an efficient system to carry out the management and control of inventories where the movements of merchandise in the plant are registered. With the system designed is intended to achieve a development of possible solutions according to the requirements of the company. Within the proposals, an inventory system based on RFID is planned.
This technology makes the identification of products by means of radiofrequency. It has a reader that is linked to a computer, which is communicated by radio waves through an antenna with a transponder (also known as a tag). RFID has existed since the 1940s with a constant use for various applications, including access control, cattle identification and electronic transport cards, among others. However, for the last few years, this technology has been growing for its support in solving control problems especially for self-service chains.

Its process begins when the chip approaches the reader and generates an electromagnetic field that causes the electrons in the antenna to move generating energy. Then the chip is energized and sends the stored information back to the reader. Radio frequency identification offers many advantages that can be used within the inventory control project, some of them are:

- RFID does not require line of sight or human intervention, so it can be automated.
- It has reading distances of 1 to 10 meters and has simultaneous reading of multiple products (anti-collision protocol).
- In addition, it can make up to 500 readings per minute (more than 5 times faster than a bar code)
- It’s perfect for production plants, as it does not affect dirty environments.

With this proposal, it is sought to create an intelligent storage system where, with the help of technology, the intervention of the operator for the registration of inputs and outputs decreases and providing more information on the existence and location of products in the warehouse, benefiting the company in diverse aspects. Our proposal is to replace current cardboard boxes with coconut shell and natural jute boxes. These boxes were designed thinking in an eco-friendly alternative way to help the environment and reduces wastes. Also, the coconut fibre boxes are as resistant as cardboard boxes.

2 DEVELOPMENT

2.1 Problem Definition

The company currently has a few problems within the plant to be totally stable and to improve its processes. One of the biggest problems is the inventory control. This problem can be perceived since entering the plant, as it is clearly seen the lack of order and storage of the products that go out of the production line to the area of packaging, where after completing the boxes, they are not properly registered and transported to the designated place in the warehouse. This process prompts that when there is a requirement for a product this is not in sight or its existence is unknown, it represents a loss in inventory. On many occasions, at the company there were ineffective decision of the realization of a new production to complete the customer's order request.

As of today, the company has a space destined for the storage of articles divided into two rooms with the same functionality, with two employees in charge of that area. The people selected for the job are those who already know the production process of glassware, since they were formerly operators of production lines and as they excelled in their performance, they were assigned this new task and were trained by the supervisory staff. The current stock count is done with the daily production record by the article in printed formats that are then digitally rewritten.

The warehouse does not have a control for the inventory of receipts and exits of the goods; leaving second-hand products (products with defects or returns) for an indefinite period, which can be renegotiated for sale at a lower price, but still will generate a profit. However, by not knowing these stocks, the location, and quantities, they only generate expenses for the company because at this moment, inventories' control are based on production by shift reported directly and automatically at the end of the shift. Inadequate organization results in entries and exits not coinciding since, if there is an unforeseen event in the packaging, in the decoration plant, or in the loss of parts due to breaks, these inventory changes are not recorded and are still being considered non-existent articles until the moment that they are revised to make a delivery.

In addition, as already mentioned, the finished products are packed and not placed in a specific place, being in the immediate output of the production line without the correct registration or in certain areas out of reach. Therefore, there is many inventory / products in their warehouses, as well as in different areas of the plant with finished and packed products without knowing what product is inside them, nor
the amount per lot. This is a problem when an order is sent, because there is no idea where the products of the order are and with greater impact on the line production, since at times the production must be reprogramed to satisfy the demand. At the same time, there is a lack of adequate personnel training which slows the process with security risks, also the current plant machinery compared to technological advances becomes obsolete.

2.2 Purposes and research scope
The general purpose of this work is to design an efficient and original system for management and inventory control with the records of the inflows and outflows of merchandise in the plant. This system implies the modification of the labelling of each product, improving the registration of the product that is exiting the production line and going into the warehouse. At the same time, a visualization of the stocks updated now to place the orders of the customer's order for their transportation and shipping is achieved. The designed system can be replicated in small and medium-sized enterprises with customization depending on the customer. Another aspect is to get rid of the traditional packaging of cardboards for products and replace them with containers made from coconut shell scraps.

2.3 RFID Technology
RFID technology (Radio Frequency Identification), is used for the wireless exchange of data, without the need for the intervention of an operator. It basically consists of communication between a reader and a card (tag). "An RFID system is an identification system which detects the signal via radio frequency using small and low-cost cards. RFID cards are attached to the product, which is achieved to transfer information automatically, fast and error-free with the readers of radio frequency waves. The three main components of RFID are the cards, the reader and the server." (Zavvari, a. et al, 2013). In Fig. 1, the three main components of RFID are shown: cards, the reader and the server, however, some require an antenna so the information can be spread and there is data exchange.

![Fig. 1. Components RFID, (Ramirez, E., Melendez, F., 2014).](image)

The cards are the fundamental element, since they gain information from the reader and transmit it, using as a mean the radio frequency signal. There are three different types of RFID cards which are categorized as passive tag, semi-passive tag and active tag. The most popular card in the industry is the passive tag because it's not expensive and its physical size is small. The passive tag cannot be used in metal objects nor computer objects. Instead, tags emit signal every 30 seconds, the process is fully automated, the transmission of the information is accurate and provides immediate notifications in any movement that is done. Each type of card has its unique way of transmitting signal. The passive tag is fed by an electronic signal emitted by the reader. The semi-passive tag requires a small battery to receive the signals by the reader. Finally, active tags require a larger battery to transfer large amounts of signals. It is considered that semi-passive and active tags have a higher cost than passive tags since they require more equipment such as battery for the exchange of signals.

The six main characteristics that have passive and active RFID systems can be shown in table 1, where the semi-passive represent a combination of both systems. As you can see, a passive tag has less power than that of the active tag, but has an unlimited lifetime and its dimension is small. An active tag has a higher cost than the passive tag since it requires an external battery for the reading of codes. Each type of system has specific qualities so it is recommended to evaluate which benefits more the organization.
The reader refers to any electronic device that can identify the presence of cards. There are different types of readers: readers with systems of single coil, which transmit power and data, they have the advantage of being simple and inexpensive, however, they have a shorter range. Readers with interrogators, depending on the transponder systems, tend to be more complex, capable of detecting and correcting errors and have a higher frequency, so it has more power, although they are more expensive. In addition, readers have an internal transcriber, very similar to the cards, which can transmit and receive signals, and are designed for different programming languages (Java, XML, Net).

The server is the software or equipment that process and stores data. Currently, there is a great variety of software on the market, each with specifications that adapt to the needs of customers. The process consists in the card, it is attached to the article (usually have a bar code) or in containers; on the other hand, readers are independent units that are found in an inspection door, a band conveyor or in a portable terminal for manual use in a forklift. The reader sends the signal of radio frequency which is received by the cards that are tuned, and these cards respond by transferring the data that is stored in them, which can be serial number, settings, or history of activity instructions.

Currently, RFID systems are fundamental to the effectiveness of the processes in the industry allowing them to improve the accuracy and speed of them. Due to major changes in technology, RFID systems have evolved dramatically and have presence in different industries. Some applications of the RFID system are the following: automated identification of objects within a warehouse, tracking library books, give access to rooms at hotels, as well as allow the entry of people through certain places such as universities, businesses, hospitals, supermarkets and even for safety of certain articles that should not abandon a certain area.

2.4 Eco box with coconut shell and natural jute

Within the value chain of any company, storage, distribution, and transportation of finished products, represent a high cost (Loera, et al. 2013). What is sought with the replacement of the traditional cardboard boxes by a biodegradable made with substrate of coconut (such as fiber) and other materials (resins, thermoplastics, and polymer fibers) is the reduction in the monthly expenditure, since this represents one percentage greater than 100% of the utility, and is due to the variety in the size of the items and the production. In addition, 50 million tons of coconut are produced annually, which implies that there is a lot of waste, and part of these are discarded and burned, so it is not reused. As is typically known, coconuts are a renewable resource and are abundant in countries close to
the Equator (tropical). The coconut fiber has very good mechanical properties, since it has high tensile strength, which increases with the fiber’s moisture. It is also very durable, with a useful life of 4 to 10 years, the reason for its high resistance in fiber is the lignin content ranging from 65% to 70%. Coconut fiber should not deteriorate over time, only then it stays under appropriate storage conditions.

Besides coconut fiber for the manufacturing of the box, jute will be used. Jute is a natural fiber that is extracted from the bark of the jute plant. This plant is considered to be the second most popular fiber plant. This natural material has many benefits as it replaces synthetic materials having the advantage of being biodegradable. Jute has certain advantages such as insulating and antistatic properties, moisture retention, low thermal conductivity and resistant to weight, impact, and load.

In general, the manufacturing process of coconut fiber boxes consists of the following steps: First, the coconut fiber is extracted and converted into a series of fine coconut shell. This can be done manually using a hammer or through a crushing fiber machine. Then, the fiber obtained, is made into small strands of approximately three centimeters. After this, biodegradable glue is created. Its ingredients are made up of 40% water and 60% flour. They are mixed and treated in fire in order to create mass. Once the coconut fiber filaments and biodegradable glue are made, they are combined homogeneously in order to create a paste. Natural jute is used in order to create defined and rigid boxes. Immediately, the paste is pressed into the various faces of the box until it’s attached in the jute. Finally, the jute and paste are left to dry in the sun for about 48 hours. The diagram of the manufacturing process of boxes made of coconut fiber is shown in Fig. 2.

3 RESULTS

With the implementation of RFID technology for the inventory control, there was a replacement of the current labels which are shown in Fig. 3, for programmable RFID Cards. Each one was programmed depending on the product being manufactured at the time of each workshop, as it is shown in Fig. 4.
Similarly, the registration of products changed because it is remotely done with the tags and with the help of the readers that receive the information and transmit it to the software, making the entries and exits of the warehouse 100% verified. Such registration is reflected in a specialized platform of computer at the store entrance, it is replacing the manual entry in excel sheets, which reduces the error rate at the time the storekeeper registers the data.

Previously, by the improper handling of the inventory in the warehouse area, there’s been losses that represent about $130,000 a year. This estimate is based on the reprogramming that has been happening in the production workshops for the manufacturing of a product whose existence, quantities and location in the warehouse are unknown, making it difficult to distribute its products. The decision of rescheduling a new production system by an amount of $13,000 is made. This cost includes energy, resource and labour costs. This information increases from 8 to 10 times in the year that happens the incident of loss of products. In addition, having goods in warehouse without movement also represents an unnecessary expenditure of storage. According to the analysis of the current state of the company, this modification will help prevent the appearance of this type of situations and recover at least 50% of the losses submitted by overproduction within a period of one year.

In Fig. 5 the layout of the plant with the RFID system is shown. On the left side of the layout, the area of Finished Products is found. Products will then move to the warehouse of finished products through an RFID reader where it will automatically capture codes of products in an efficient way. Because of this, there will be an automated record of the entries and exits of inventory.
On the other hand, current cardboard packaging will be replaced for Coconut fibre boxes as it uses 14,000 sheets per month at a cost of $300,00. It is expected that this improvement will diminish cardboard waste and costs by using a biodegradable material that is used only for gardening applications. Manufacturing process of coconut fibre, permits these boxes be more resilient, have a useful longer life and be reused. Customers can return these boxes to the plant with a certain compensation to be used again. To replace the cartons with these new boxes, it is necessary to carry out more tests and experiments that allow the development of folding packages to obtain the desired shape without having to do it from the beginning. The manufacturing process must also be more efficient to have a mass production.

4 CONCLUSION

The implementation of an RFID system in the organization will decrease dramatically costs of inappropriate control of storage, a mishandling of materials and processes that do not generate value to the final product, since it integrates all these activities having an automated control of inputs and outputs of products. In addition, this system can replicate in small and medium-sized enterprises that have the same production capacity, productivity, plant size and variety of products.

We evaluated the situation of the company and suggested the ideal RFID system that benefits more depending on their needs. All of this to eliminate the problems that are currently present, reducing costs, which is reflected in the increase of its profits.

In the same way, an ecological alternative is added to the current cardboard boxes by a container of coconut fibres and natural jute with the same function extending the life and giving them greater uses recovering the waste that exists of coconut shells. These boxes are made of 100% natural materials, so they are totally biodegradable and eco-friendly.
REFERENCES


