

Study of Intelligent Secure Chemical Inventory Management System

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Abstract. Chemical inventory management system has been experiencing a new revolution from traditional inventory system which is manual to an automated inventory management system. In this paper, some review of the classic and modern approaches to chemical inventory management system has been discussed. This paper also describe about both type of inventory management. After a comparative analysis of the traditional method and automated method, it can be said that both methods have some distinctive characteristics. Moreover, the automated inventory management method has higher accuracy of calculation because the calculations are handled by software, eliminating possible errors and saving time. The automated inventory system also allows users and administrators to track the availability, location and consumption of chemicals. The study of this paper can provide forceful review analysis support for the chemical inventory management related research.

1. Introduction

Inventory systems are tracking systems that inform user of the amount of raw materials, supplies or final products you have readily available. According to Subramaniam et. al, inventory has traditionally been viewed as a necessity to meet customers' demand. Higher levels of inventory result in increased responsiveness of the supply chain, but decrease the cost efficiency because of the cost associated with holding inventory. Therefore, inventory management is one of the important aspects of supply chain management because the cost of inventory can represent anywhere between 20% and 40% of the total value of the product [1].

The importance of inventory management systems are basically to avoid stock outs, overstocks, losses, damages, misuses and some other details or descriptions of the items. Same goes to chemical



inventory management system, according to Lester Bynam, some of high school management did not realised the importance of chemical inventory management system [2]. Chemical inventories found in high schools contain a vast array of chemicals ranging from safe and suitable for education at the secondary level to extremely hazardous, unsuitable and inappropriate for those unknowledgeable or untrained in their use and potentially harmful to the environment.

2. Related Work

Year by year, chemical inventory system has been experiencing a new revolution from traditional inventory system to automated inventory system. Chemical laboratory admin and assistant had to rely on their hand-written notes and gut feelings to place orders. It was extremely difficult to account for stolen or broken chemicals apparatus because it would take laboratory admin and assistant hours or even days to hand count all physical inventory to see if anything was missing. Now, chemical inventory management system completely transform from traditional method to automated method in order to increase their management efficiency. Both type of chemical inventory management are shown in Figure 1 below.

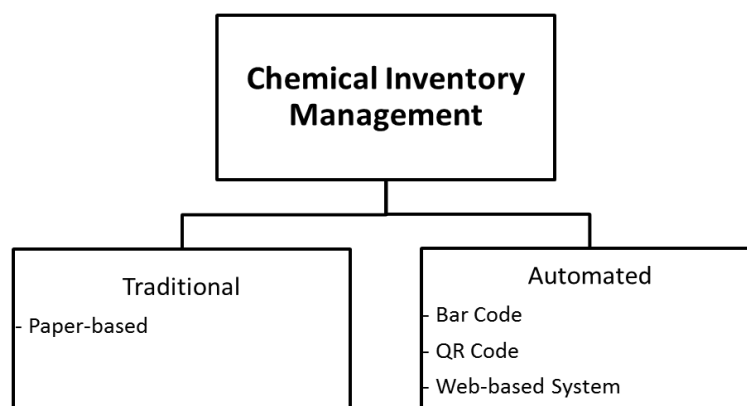


Figure 1. Type of Chemical Inventory Management

2.1. Traditional Inventory Management

One of the traditional method of inventory management is manual monitoring of stock level. These traditional systems also include simple eye assessment when a lab assistant would stand in the middle of laboratory and based on visual observations, decide which items are short in inventory and need replenishment. The system was also based on manual calculations being made on stock level using Fixed Order Quantity where particular amount of order was placed once stock reaches a particular level, or Fixed Order Interval where order was placed at predefined intervals without considering the current stock [3].

Other than that, those days also used manual lab safety checklist. All the safety instruction and also hazard report are paper-based. They have to write the report by-hand manually and send to keep in in hard copy file. They also need to print the picture and put inside the report.

2.2. Automated Inventory Management System

In parallel with the passage of the latest technology, chemical inventory management system has been updated from manual management method to automated management method using barcode, QR code and web-based system in order to increase their lab management efficiency.

2.2.1. Barcode system. A modern bar-code reader was introduced in 1948 for easy use [4]. Bar-code labels are attached or printed on all chemical tanks and chemical bottles including a photo resist. Data input should be easy and data retrieval should be quick thru a system. Operators working in a stock house read a bar-code by using a wireless barcode reader for easy use. If inventory quantity becomes lower than a safety stock point while waiting for the delivery. A manager or floor supervisor will receive a warning message thru E-mail. Also CIS forecasts a zero stock date based on the last consumption rate [5]. LabCup's chemical inventory module has been developed by LabCup Company. This system provides complete chemical tracking across an institution [6]. This includes everything from using chemicals within the lab, Safety Officer oversight, chemical waste disposal and more. Every chemical is uniquely tracked by barcode ID. The main chemical inventory section of LabCup is designed to cater to researchers needs, to automate as much of the process as possible, give them access to information when they need, and make it simple to use. The researchers can find their chemical instantly, so they can spend their time on their actual research work. The example of screenshot of the system as shown in Figure 2.

The screenshot displays the LabCup Chemical Inventory System interface. On the left is a form for entering chemical details, and on the right is a detailed 'Safety information' section.

Form Fields (Left):

- Owner: CRANN-demo group
- Resp. person: demo-user
- Location: Cabinet 1
- Laboratory: CRANN-demo lab
- Barcode * (with a camera icon for capture)
- Brand *
- Product No *
- Name on the bottle *
- Quantity
- A button labeled 'CAPTURE FRONT LABEL' with a camera icon.

Safety information (Right):

- Navigation tabs: BASIC INFORMATION, COMPONENTS, LOCATION, SAFETY INFORMATION (selected).
- Section title: Safety information
- Safety Data Sheet (SDS): OPEN
- DIRECT LINK TO THE COMPANY'S SDS PAGE
- COMPANY'S SDS SEARCH PAGE
- Risk analysis:
 - Thermal radiation: 2.12e-5 (freq:4.24e-4, sev:5.00e-2)
 - Toxic effects (TODP): 1.84e-3 (freq:3.68e-4, sev:5.00e+0)
- Risk assessment forms: SHOW FORMS
- 2.1 Hazard classifications:
 - Flammable liquids (Category 3).
 - Serious eye damage (Category 1)
- 2.2 Pictogram: (Flammable and Corrosive icons)
- 2.2 Signal word: Danger

Figure 2. Screen Shot of the LabCup's Chemical Inventory System

2.2.2. QR Code system.

In 2015, VelocityEHS, a software company has produced an automated inventory management system which is MSDSonline Chemical Inventory Scanner [7]. This system basically used device's camera, and scan a QR Code label to retrieve and edit the status of the lab chemical containers. All changes automatically update the inventory in the online account. MSDSonline a compliant chemical inventory starts with knowing what materials are onsite, where they are used/ stored, their precise quantities, and ensuring each has an MSDS QR Code. This Chemical Inventory Scanner mobile application works seamlessly with an MSDSonline HQ or HQ RegXR Account, giving user a quick and easy way to locate and manage the contents of chemical containers in the workplace. User can also scan the QR Codes to retrieve product information and the MSDS document. The example of screenshot of the system as shown in Figure 3.

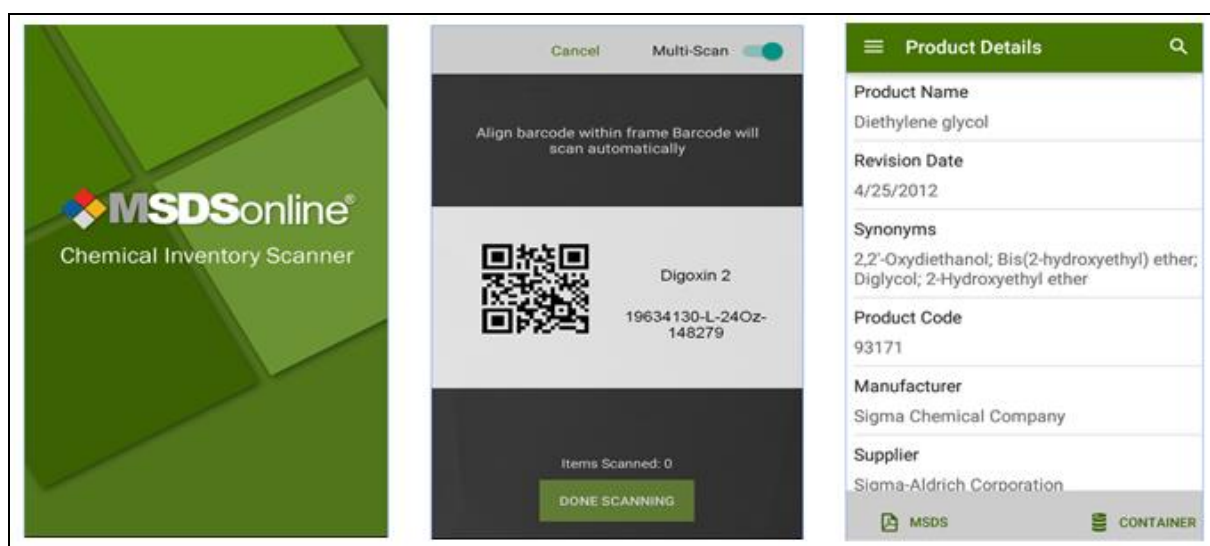


Figure 3. Screen Shot of the MSDSonline Chemical Inventory Scanner Application

2.2.3. Web-based system.

Jaclyn et. al has develop a Web-based inventory-keeping software as a web-based inventory management system [8]. This system developed using PHP and MySQL that provides chemical information such as safety data sheets that tracks individual chemical bottles using a barcode system to monitor stock-levels, consumption, movement and expiration which complies with government regulations on controlled chemicals and hazardous chemical wastes; facilitates sharing of chemicals among different departments, and stores supplier information.

This system has four user levels with increasing functionality which are students, faculty members and researchers, head of department, staff and technicians, and system administrator. The system architecture design of this Web-based inventory-keeping software as shown in Figure 4.

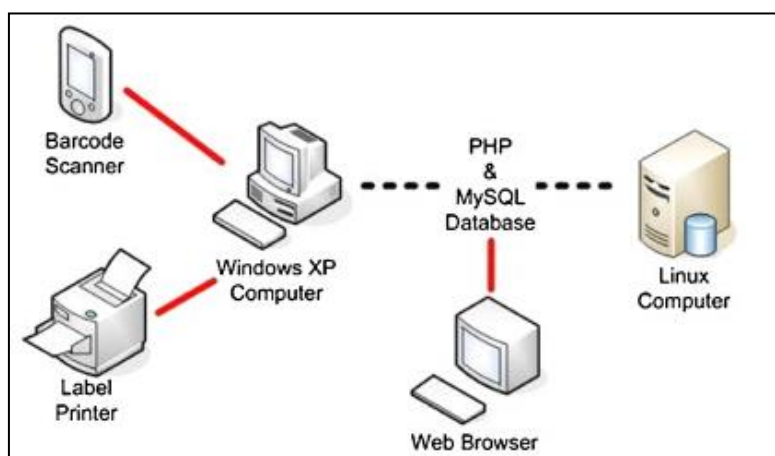


Figure 4. System Architecture Design of This Web-based Inventory-keeping Software

3. Discussion

As of now, chemical inventory management system can be divided into two groups of system which is traditional inventory management and also automated inventory management. Both type of inventory management has their own advantages and disadvantages. The details or description for the both type of inventory management as shown in Table 1.

Table 1. Description of the Inventory Management Type

Inventory Management Type	Description
Traditional inventory management	- Order placement. Orders were placed manually on a telephone, fax and mail unlike the modern technology driven systems where integrated software system takes care of placing and processing orders without employee input. - Lack of supplier responsibility and accountability. - High transaction cost contribution to product due to paperwork processing cost.
Automated inventory management	- With the chosen web-based application architecture, access and use of the system is easily managed. - The system can be deployed through the Internet for a multi-campus university or for use by other universities or institutions. - The system is primarily an inventory-keeping software that allows users and administrators to track the availability, location and consumption of chemicals. - Document Generation Improved. Once the computerized inventory management system is in place, lab assistant can use it to automatically generate all kinds of documents, from purchase orders and checks to invoices and account statements [9]. - Calculations are handled by software, eliminating possible errors and saving time. Accuracy of calculations of computerized system ensures reliability of financial statements prepared by computers [9].

4. Conclusion

The existing chemical inventory management system presented in this review where we have traditional method and automated method show us the revolution of inventory management system in order to increase the functionality of this inventory management system. After a comparative analysis of the traditional method and automated method, it can be said that both methods have some distinctive characteristics. Moreover, based on the description in discussion section, we can conclude that automated inventory system more suitable than traditional inventory method especially for chemical inventory management system. With the chosen web-based application architecture, access and use of the system is easily managed. Other than that, the system can be deployed through the Internet for a multi-campus university or for use by other universities, institutions, and faculties. Last but not least, the automated system or software can allow users and administrators to track the availability, location and consumption of chemicals. So, it shows that an automated system is more suitable for chemical inventory management system.

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