Designing Intelligent Secure Android Application for Effective Chemical Inventory

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Abstract. Mobile services support various situations in everyday life and with the increasing sophistication of phone functions, the daily life is much more easier and better especially in term of managing tools and apparatus. Since chemical inventory management system has been experiencing a new revolution from antiquated to an automated inventory management system, some additional features should be added in current chemical inventory system. Parallel with the modern technologies, chemical inventory application using smart phone has been developed. Several studies about current related chemical inventory management using smart phone application has been done in this paper in order to obtain an overview on recent studies in smartphone application for chemical inventory system which are needed in schools, universities or other education institutions. This paper also discuss about designing the proposed secure mobile chemical inventory system. The study of this paper can provide forceful review analysis support for the chemical inventory management system related research.

1. Introduction

In the earliest days of chemical inventory managing system, laboratory assistant wrote down the chemical stocks purchase, or they looked at how many units were gone, expired or damage at the day’s end and the n did their best to forecast future needs. When inventory management system has their revolution, there are many options available today that have change the landscape of chemical inventory management from even 10 years ago. Software or automated system makes chemical inventory tracking easy, allowing laboratory assistant keep real-time inventory and monitor chemical usage. In terms of managing the chemical stock, there will be an easy task for assistant laboratory because with the existing automated chemical inventory management system.

While size and complexity differ considerably among laboratories, every lab manager must master a few essential tasks. They fit into two main categories: overseeing physical assets and managing human resources, with the synergistic goal of maximizing efficiency. Traditional chemical inventory management systems have a tendency to create menial tasks for the whole organization, from spending time searching for chemical containers to reordering stock that can’t be found. After years of research, what may seem to be inconsequential losses of time and funds can add up to a serious amount of wasted resources [1]. This affects not only the qualitative environment of the lab but also your organization’s long-term operational costs.

Besides that, according to Lester Bynam, (2009), 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. So, in order to maintain lab safety compliance
more efficiently, chemical laboratory may need to consider the implementing a digital or automated chemical inventory management system.

This paper consists of four main sections and organised in sequence as follows;

- Section 1 describes about introduction that introduced the idea and concepts of the chemical inventory management system.
- Section 2 provides reviews about researches that have been done in similar scope and also related to this project. This section also discusses about the characteristics for every system that have been reviewed to improvise the proposed system.
- Section 3 presents discussion and explanation about the system design and development process. This section also describe about the interfaces of the proposed system.
- Section 4 discusses about the implementation and conclusion of this proposed system.
- References section consists of the list of all references used in this paper.

2. Related Work
In parallel with the passage of the latest technology, chemical inventory system has been experiencing a new revolution from antiquated or traditional inventory system to automated inventory system. For traditional method, manual entry in inventory spread sheets can often open opportunities for human error[3]. Hence, chemical inventory management system has been updated from manual management method (paper-based) to automated management method using barcode, QR code and web-based system via smart phone in order to increase their lab management efficiency.

2.1. Current Related Inventory Management
Of late, many devices and smart phones have been used widely for similar related purposes. Previous studies have shown that many researchers and developers have developed automated inventory related system. They use smartphones to efficiently check in, check out and look up detailed information on assets and inventory by scanning barcodes or QR codes. Therefore, more researches need to be conducted to improve the technology and capabilities of smart phone to meet the requirement in conducting the chemical inventory management in laboratory.

2.1.1. EMS. Inventory system.
EMS.Inventory is an Android mobile app developed by Chemical Safety Software that helps monitor, move and update chemical containers from cradle to grave (also known as purchase through disposal)[4]. EMS.Inventory records and updates chemicals from the moment they are received on site, distributed, stored, used and disposed. By controlling and updating chemical quantities and storage locations, chemical inventories are stored with compatible chemicals only and never exceed permitted limits. This improves workplace safety and reduces acquisition and disposal costs. MS.Inventory is used alongside Chemical Safety’s EMS cloud-based application. It reduces recordkeeping time, streamlines chemical purchasing, and facilitates distribution, sharing and disposal of chemicals. With EMS.Inventory, information is updated in real-time, which allows for timely and accurate management and regulatory reporting. Employees, Lab personnel and management can quickly assess and validate information onsite at any time. The example of graphical user interfaces (GUI) of the system as shown in Figure 1.
2.1.2. **MSDSonline Chemical Inventory Scanner.**

In 2015, VelocityEHS, a software company has produced an automated inventory management system which is MSDSonline Chemical Inventory Scanner [5]. 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 graphical user interfaces (GUI) of the system as shown in Figure 2.
2.1.3. SafeLab Application.
Safe Lab application is an android based application developed by XDeveloper Software Company in India [6]. This application was developed for safety lab information and inventory-keeping software as a chemicals inventory management system. This application has safety chemical features. It can show the details and the meaning of important chemicals safety symbols for example the chemicals is irritant for skin and eye. So, the lab user will know the safety level of the chemicals in the lab. This application also can generate the chemicals label for new chemicals. Lab assistant can add the details of the new chemical for labelling, and then the application will save as an image. Then, the lab assistant can print that label and use it to the new chemicals container. The example of graphical user interfaces (GUI) of the Safety Lab Application as shown in Figure 3.

![Figure 3. Graphical User Interfaces of the Safety Lab Application](image)

2.2. Comparing Selected Current Related Inventory Management Application for Review
In order to get an overview of studies about current related chemical inventory management using smart phone application, a comparison between all three application is needed. It is important to obtain an overview on recent studies in smartphone application for chemical inventory system which are needed in schools or universities nowadays, and to compare how those apps are running which can help for inventory management.

Some characteristic was discussed in order to get the best characteristic for the new proposed chemical inventory application. Some of the characteristic needed is user authentication, chemical description access via smart phone, chemical availability monitoring access, and updating chemicals description. User authentication is needed to control the lab data only can be access by registered lab user. Besides that, chemicals description access via smart phone also needed to avoid lab user from touching the chemicals container without knowing the chemical’s hazardous description. So, the lab user just read the chemical’s hazardous description on their smart phone instead of reading at the chemicals container. Other than that, chemicals availability monitoring access via smart phone also important for lab user or lab assistant to know and monitor the stock availability in order to ensure the lab chemicals always available for lab user. The another characteristic that needed for the chemical inventory application is updating chemicals description. This is important for lab assistant to update
latest chemicals description. The comparison of current related chemical inventory management using smart phone application as shown in Table 1.

Table 1. Comparison for Selected Current Related Inventory Management Application

| Chemical Application                        | System authentication | Chemicals description access via smart phone | Chemicals availability monitoring access | Updating chemicals description |
|--------------------------------------------|-----------------------|---------------------------------------------|------------------------------------------|-------------------------------|
| EMS Inventory System                       | No                    | Yes                                         | Yes                                      | No                            |
| MSDSonline Chemical Inventory Scanner Application | No              | Yes                                         | No                                       | No                            |
| SafeLab Application                        | No                    | Yes                                         | No                                       | Yes                           |
| Proposed Secure Mobile Chemical Inventory System | Yes             | Yes                                         | Yes                                      | Yes                           |

3. Designing Application
Based on the comparison of current related chemical inventory management using smart phone application in previous section 2.2, and also in Table 1, there are some basic specifications or characteristics needed in the new proposed secure mobile chemical inventory system. All the characteristics which is user authentication, chemical description access via smart phone, chemical availability monitoring access, and updating chemicals description will be main functional component for the proposed system.

3.1. Comparison QR Code and Bar Code
Studies from previous section 2.2, bar codes or QR codes is needed at chemical container in order to store the chemical product description. When debating on the issue of barcodes versus QR codes, as far as data types, barcodes are one dimensional numeric codes, and they are capable of up to 20 characters. This is simple for keeping track of inventory that leaves and enters a store, ensuring that retailers are constantly aware of what they have on hand. QR codes are two dimensional codes, capable of storing data horizontally and vertically. Therefore, the QR codes can hold up to 7100 characters of data, rather than the much lower number which barcodes hold. Additionally, the QR codes hold characters, numbers, symbols, text, and control codes. Due to the fact that the codes are horizontal and vertical, they store the same exact amount as the barcode can, but in only 1/10 of the space the barcode requires. So, when choosing barcodes versus QR codes, in the arena of data storage, QR codes are far greater at holding and keeping storage, and can even store text messages or website addresses [7].
3.2. Designing Graphical User Interfaces for Proposed Secure Mobile Chemical Inventory System

Proposed secure mobile chemical inventory system will have a user authentication to protect data for the chemical lab. Proposed application also will use the QR code as a medium to store the information or details of the chemical. System was built in with the QR code scanner in order to read the chemicals detail on the smartphone. This proposed system also able to edit the data especially regarding the quantity of chemical stock to ensure the availability of the chemical stock. The example of graphical user interfaces (GUI) of the proposed secure mobile chemical inventory system as shown in Figure 5.

![Figure 4. Bar Codes and QR Codes](image)

![Figure 5. Graphical User Interfaces of the Proposed Secure Mobile Chemical Inventory System](image)

This proposed secured mobile chemical inventory system has the log in page which is the process by which an individual gains access to this system by identifying and authenticating themselves. This log in page is important in order to prevent unauthorized users from misuse the system. When the log in process successful, user can use the system to scan the QR code and get the chemical product details such as chemical’s name, manufacturing date, expired date, quantity, vendor, location and also description about that chemical. By scanning the QR code, the lab assistant can monitor the chemical availability and straight away update the chemicals description.
4. Conclusion
Implementing mobile application or automated system makes chemical inventory tracking easy, allowing laboratory assistant keep real-time inventory and monitor chemical usage. Besides that, chemical laboratory need to consider the implementing a digital or automated chemical inventory management system in order to maintain lab safety compliance more efficiently. Based on study and discussion in the earlier subtopic, chemicals description access via smart phone also needed to avoid lab user from touching the chemicals container without knowing the chemical’s hazardous description. So, the lab user just read the chemical’s hazardous description on their smart phone instead of reading at the chemicals container. QR codes is needed at chemical container in order to store the chemical product description. Besides, the smart phone inventory system also need to be able to scan the QR code to ensure that chemical description can be read via smart phone. Last but not least, by using an automated system such as secure android application for chemical inventory management system, can maintain lab safety compliance more efficiently.

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