A USER ACCEPTANCE OF CHEMICAL MANAGEMENT SYSTEM (CMS) USING KANSEI ENGINEERING

Submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (Hons.)

by

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I declared this report “A User Acceptance of Chemical Management System (CMS) using Kansei Engineering” to be the results of my own research except as mentioned in the reference.

Signature :……

Author’s Name : Laavanya A/P Sothi

Date : 10 Januari 2020

APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of Universiti Teknikal Malaysia Melaka as partial fulfilment of the Bachelor of Manufacturing Engineering (Hons.) requirements. The Supervisory Committee member is as follows:

……..

(Ts. Dr. Suriati binti Akmal) -Signature & Stamp

ABSTRAK

Persekitaran yang selamat dan sihat adalah penting kepada semua pekerja. Sistem pengurusan inventori kimia yang lemah di makmal adalah satu cabaran besar kepada pembantu makmal untuk menjejaki, mengekalkan dan meminimumkan sisa kimia secara manual. Tujuan kajian ini adalah untuk mencapai satu sistem untuk menguruskan inventori kimia yang ditentukan menggunakan FMEA dan Ishikawa Diagram dan ditetapkan oleh Kansei. Beberapa punca yang membawa kepada masalah yang sedia ada telah dikenal pasti semasa perbincangan dan temu ramah dengan pembantu makmal. Penyebab dan kesan isu ini telah dikenal pasti menggunakan Rajah Ishikawa (*Fishbone*), dan penyelesaiannya didapati melalui analisis FMEA. Keperluan pengguna ke arah sistem yang dibangunkan telah ditentukan semasa fasa ini menggunakan kaedah soal selidik dengan menggunakan konsep Kejuruteraan Kansei. Perkataan Kansei yang dipilih oleh pengguna adalah; bermaklumat, memahami, responsif, mudah dan mudah. Keberkesanan sistem yang dicadangkan telah dinilai melalui kaedah kebolehgunaan yang melibatkan kumpulan responden yang sama. Sistem berasaskan web yang dicadangkan menjaringkan 65.33 sedikit lebih rendah daripada skor sejagat, 68 dalam Skala Penggunaan Usul Sistem (SUS). Data ini dalam kajian ini menunjukkan bahawa Sistem Inventori Kimia telah memenuhi keperluan pengguna namun memerlukan beberapa penambahbaikan. Sistem yang dicadangkan mengatasi amalan semasa rakaman manual yang luas. Ia memudahkan pembantu makmal untuk mengekalkan pangkalan data kimia yang komprehensif, menyeragamkan pengurusan inventori kimia-menjejaki di seluruh makmal di FKP, UTeM.

ABSTRACT

A safe and healthy environment is vital to all workers. Poor chemical inventory management system in a laboratory is a big challenge to the lab assistants to consistently tracks, maintain and minimising the chemical waste manually. The purpose of this study is to accomplishing a system for managing the chemical inventory that is determined using the FMEA and Ishikawa Diagram and stipulated by Kansei. Several causes that led to the existing problem was identified during discussion and interview with the laboratory assistants. The cause and effect of this issue were identified using the Ishikawa Diagram (Fishbone), and the solutions were found through FMEA analysis. The user requirements towards the developed system were determined during this phase using questionnaire method by applying Kansei Engineering concept. The Kansei words that chosen by user's are; informative, understand, responsive, easy and simple. The effectiveness of the proposed system has been evaluated through usability methods involving the same group of respondents. The proposed web-based system scored 65.33 slightly lower than the mean global score, 68 in System Usability Scale (SUS) Test. This data in this study indicates that the Chemical Inventory System has fulfills the user's requirement yet requires some improvisations. The proposed system overcomes the current practice of extensive manual recording. It facilitates the lab assistants to maintain a comprehensive chemical database, standardise the management of chemical inventory-track-maintain across laboratories in FKP, UTeM.

DEDICATION

DEDICATED

TO MY DEAREST PARENTS

Mr Sothi a/l Sinnappan and Ms Patmavathy a/p Ponnusamy

TO MY HONOURED SUPERVISOR

Ts. Dr. Suriati binti Akmal

For her advice, support, motivation and guidance during the accomplishment of this project

TO ALL LECTURERS & TECHNICIANS

For their support and advice during the completion of this project

TO MY SUPPORTIVE FRIENDS

For giving me moral support, encouragement and also cooperation.

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ABBREVIATIONS

CIM	-	Chemical Inventory System
CMS	-	Chemical Management System
FKP	-	Fakulti Kejuruteraan Pembuatan
FMEA	-	Failure Mode and Effect Analysis
FOQ	-	Fixed Order Quantity
FOQ	-	Fixed Order Quantity
IoT	-	Internet of Things
LAN	-	Local Area Network
OSHA	-	Occupational Safety and Administration
NIOSH	-	National Institute of Occupational Safety and Health
OSHA	-	Occupational Safety and Health
PSM I	-	Projek Sarjana Muda 1
PSM II	-	Projek Sarjana Muda 2
QR	-	Quick Response
RFID	-	Radio-frequency identification
RPN	-	Risk Priority Number
SUS	-	System Usability Scale
TPS	-	Toyota Production System
UTeM	-	Universiti Teknikal Malaysia Melaka

CHAPTER 1

INTRODUCTION

In this chapter, the context of the project will brief about the background of the study, objective, problem statement, scope of the project and importance of the study.

1.1 Background

A few years back, the inventory management system that practice in chemical laboratories are more towards traditional method at where the laboratory assistant wrote down the purchased chemical stocks, number of units that used, expired or damage chemicals and they predict the amount chemical stocks for future need. But, after the inventory management system has faced the revolution, there are multiple ways to manage the chemical inventory system according to laboratory space, users preference and also laboratory assistants needs. The chemical inventory tracking systems become way more manageable with the use of either automated system or software. Other than that, the software or automated system also allows the lab assistant to monitor chemical usage and keep real-time inventory. It becomes an easy task for assistants to manage the chemical stocks in the laboratory with the aid of existing automated chemical inventory system (Mohd Shukran et al., 2017a)

All workers are entitled to work in a safe and healthy environment. However, workers should understand how to effectively work in a safe and healthy environment, especially who are dealing with hazardous materials. Managing the hazardous material is one of the most effective strategies for reducing the cost of work-related disease, injuries and waste disposal in the working environment. Latest statistics from the Department of Occupational Safety & Health Malaysia, (2014) states that there are 3.10% of 1000 workers and 4.21% of 100,000 workers involved in accident and fatality in the working environment (DOSH, 2014).

OSHA has the primary aim of promoting safety and health awareness and culture among Malaysia workforce. All university laboratories in Malaysia without exception are subject to the enforcement of the act. The students use the laboratory for a practice session in gaining more details on the theory learned. Also, research material-related activities are becoming more extensive in developing new material occurs in the university laboratories throughout the countries.

Maintaining up-to-date chemical inventories can also reduce the hazards in the laboratory by merely reducing the amount of hazardous material on-site (National Research Council. 2011). Chemical laboratories should evaluate their chemical inventory regularly and dispose of undesirable and obsolete chemicals. Ordering the only required quantity of chemicals which is required for specific projects can reduce chemical waste in laboratories and avoid paying for hazardous waste disposal. Ordering large amounts of chemicals to save money may end up costing more money once the excess quantity is disposed of. Thus, ordering the necessary amount of hazardous material needed and reusing materials is an effective way to minimise harmful waste generation (Vallero, 2011).

OSHA has been existence more than a decade in Malaysia, but the implementation of OSHA management system among the academia and researcher still at the infant stage. The chemical inventory system is a tracking system that informs the user of hazardous material, from their procurement to their disposal. The chemical inventory system represents between 20% - 40% of the total value of the product. In response to the OSHA, the essential of the chemical inventory management system is still a critical element in providing laboratory as a safe and healthy workplace. Further, the manual (paper-based) inventory

management system that is currently used by many laboratories are prone to unsecured and out-of-date data of hazardous material.

It has been proven, based on studies conducted, that the relationship between lean manufacturing and working environment is always interrelated due to sustainable workplace performance (Veza et al., 2011). Lean manufacturing is one of the factors that must be considered to achieve a pleasant working environment. Lean manufacturing is an applied methodology of scientific, objective techniques that cause work tasks to be performed in a process with a minimum of non-value adding activities resulting in significantly reduced waiting time, queue time, moving time, administrative time and other delays. The focus on value is a critical point in lean thinking.

Safe environment plays an important role to constitute and maintain improved quality, productivity in the principles of an organisation 5s (Randhawa, 2017). Lean is one of the most popular concepts practised in most companies. However, many companies that implement lean and do not realise whether a lean practice is improving or relegating (Veza et al., 2011) Thus, this study investigates the effect on chemical inventory system using lean manufacturing practice.

The human-computer interaction interface assessment is distinct from the physical product evaluation, and it is more difficult to measure the user experience of the device. The benefit of Kansei engineering is to establish a link between the product's feature attributes and the user's perceived experience (Wu et al.,2019). In recent years, many related studies have been evaluated using a Kansei engineering approach. Kansei engineering's application has gradually expanded from product evaluation to more fields. For example, Rizzi et al. used Kansei engineering to evaluate the alternative distribution of colour and contrast in the interface (Goh, Chen, Daud, Sivaji, & Soo, 2013).

Tharangi uses a Kansei engineering method to evaluate the human-machine interface, and it is concluded that emotional colour changes play a significant role in the interaction between people and computers. Fu et al. explored the use of Kansei development methods to improve website design. Hadiana and Abdurrohman used Kansei engineering to assess the satisfaction of business processes (Wu et al.,2019). Therefore, this research

applying Kansei engineering to understand the emotion of human while using developing software.

1.2 Problem Statement

Rarely every university practices proper inventory management in chemical laboratories due to lack of awareness (Abbas, Zakaria, Balkhyour, & Kashif, 2016). Usually, chemical laboratories use a manual inventory system. Even though manual inventory systems have their advantages, but the disadvantages are highly noticeable, which needs more improvement in the inventory system in every chemical laboratory.

The disadvantages of manual inventory systems are facing with the surplus of chemicals, difficulties in tracking the owner of the chemical, unknown expiry date and no automatic notification to the owner and laboratory assistants. Besides, the manual inventory system also causes improper workflow in laboratories and wasting time in waiting for chemicals to stock up.

Apart from that, most of the chemical inventories found in universities contain an enormous array of chemicals ranging from harmless, and several chemicals are highly hazardous and potentially destructive to the environment.

Therefore, this study focuses on implementing an automated chemical inventory management system in the chemical laboratory of Universiti Teknikal Malaysia Melaka (UTeM), in order to sustain the lab safety compliance more efficiently and to facilitate the laboratory assistants to manage the chemical inventory without any complications.

1.3 Objective

Despite the efforts made in previous related research work, it is not yet clear how the integration of chemical inventory management can benefit both laboratory assistants and users. Consequently, this study aims to identify a solution for current inventory management in chemical laboratories to reduce the chemical wastage and increase the efficiency of workflow. On the other hand, it wants to ensure benefits for chemical laboratory users in terms of usability issues. Thus, the problems should be identified and analysed for better inventory system in chemical laboratories. The objectives of this study are as follow:

i. To analyse cause and effects in the current chemical inventory system.
ii. To recognise relevant development tools for developing a web-based Chemical Inventory System to ease the workflow in chemical laboratories.
iii. To evaluate the usability of the web-based Chemical Inventory System.

1.4 Scope

This project focused on how to improve the inventory system in chemical laboratories in UTeM. In this project, to propose a better Chemical Management System (CMS), the traditional and non-traditional (automated) method will be compared.

The scope of this study focuses on chemical laboratories in the Faculty of Manufacture Engineering, FKP in Universiti Teknikal Malaysia Melaka (UTeM). An interview session is conducted with one of the chemical laboratory assistant to analyse the problems faced in the chemical laboratory. For the study purpose, the questionnaire was distributed to a sample size of 15 respondents which consists of laboratory assistant's, lecturers, post-graduate students and also undergraduate students who were chosen from FKP, UTeM. The purpose of this questionnaire conducted is to obtain feedback on current chemical inventory management. Moreover, few SPC such as Failure Mode and Effect Analysis (FMEA) and Ishikawa method (Fishbone Diagram) is used to identify and evaluate the causes of this issue. Kansei Engineering and System Usability Score test also apply in this research to achieve the objectives.

1.5 Significant/ Importance of Study

The contribution of this study will be an advantage that can be earned by FKP, UTeM once this research is completed. The improvement of chemical inventory management can help to overcome all the issues faced by laboratory assistants and laboratory users. Other than that, the long period implications of this study will reduce the chemical wastage in laboratories, minimise the cost of inventory and also increase the safety precautions of users in the laboratory. shorten the chemical managing time. Finally, the findings of this study will improve the chemical inventory system in FKP, with the implementation of automated chemical inventory system with the digitizing and reduce the accidents occurs in the laboratory due to users carelessness behaviour. Thus, this research will overcome accidents in chemical laboratories and increase the efficiency of the chemical inventory system.

1.6 Thesis Organization

This thesis is divided as follows into 5 chapters includes:

Chapter 1: This chapter introduces the project which includes this project's background, statement of problems, objective, scope and importance of the study.

Chapter 2: This chapter describes the review and theory of literature related to this project and any previous research that may assist in supporting this research.

Chapter 3: This chapter explains the method, process and steps that used to conduct this investigation.

Chapter 4: This chapter explains the outcome and discusses the result obtained.

Chapter 5: This chapter concludes the test result, discuss the limitations faced while conducting this study and also provides recommendations for future study.

CHAPTER 2

LITERATURE REVIEW

The purpose of this chapter is two folds: first, it reviews the existing literature to identify the research gap addressed by this study. The motivation of this study is drawn from the literature review that serves to provide the theoretical and recent development of knowledge relevant to the study. The main purpose of the literature review is to identify the problems or gaps in the existing approaches related to the analysis of trust requirements model in developing autonomous cars acceptable by users. Next, it serves to identify the significant attributes of trust. Lastly, it provides the theoretical and recent development of knowledge relevant to the study, and it presents the conceptual framework of this research.

2.1 Safety and Health Environment

2.1.1 OSHA

Occupational Safety and Health (OSHA) is a cross-disciplinary area which is concerned with protecting the safety, health and welfare of people patronising any organisation. Foster a safe work environment is the primary goal of all occupational health and safety awareness programs (Ahmad, 2010). A recent study proposed that a healthy work environment provides a platform for employees to have a quality work-life, which leads to positive spillover effect (Noor and Abdullah, 2011). Furthermore, Malaysian NIOSH chairman suggested that “OSHA awareness had been identified as a pre-condition

for increased productivity". Hence, OSHA should not consider as a burden to the organisation but instead as a catalyst for productivity and profitability by the employers. Figure 2.1 shows the statistics of injuries occurs in working place increase drastically every year, which leads to either fatality or accidents (Jisha, 2018).

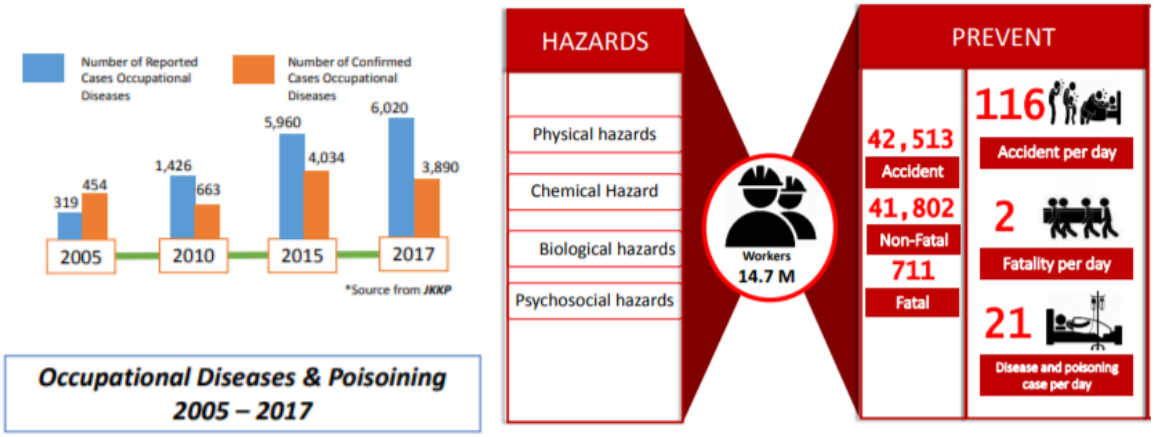

Figure 2.1 Statistics of Injuries in Working place (Jisha, 2018)

2.2 Lean Manufacturing

Lean Manufacturing is the systematic method, derived from Toyota Production System (TPS) in the 1990s, which focuses on eliminating waste, reducing inventory, improving throughput and encouraging employees to bring attention to problems and suggest improvements (Womack et al., 1990). It is used by many organisations worldwide. Similarly, Veres et al. (2018) found that the primary aim of lean is to eliminate waste through the creation of value-added to products or services. Any expenditure of resources that do not add value for the customer is considered a waste. Thus, before lean practice, an organisation should have a clear understanding of the concepts of value-added. According to the theory, waste is categorised in many ways. Veres et al. (2018) stated that the waste is classified into overproduction, over-processing, defects, inventory, transportation, motion, underutilisation and delay in lean manufacturing.