PERINTIS eJournal

PERINTIS eJournal, **2019**, Vol. 9, No. 1, pp. 30-47

ASSESSING USECHH REGULATION 2000 IMPLEMENTATION ON CHEMICAL LABORATORIES: A CASE STUDY OF UNIVERSITI TEKNOLOGI MALAYSIA

Nursyazwani Aznan, Mazura Jusoh, Zaki Yamani Zakaria*

School of Chemical & Energy Engineering, Faculty of Engineering, Universiti Teknologi Malaysia, 81310, UTM Skudai, Malaysia

*Corresponding Author: zakiyamani@utm.my

ABSTRACT

Chemical laboratories safety has become an important issue in Universiti Teknologi Malaysia (UTM), as many accidents occurred in the laboratory such as spillage and explosion. By using USECHH Regulation 2000 as the baseline study, this research was conducted on 18 chemical testing laboratories in UTM which are divided into Service Lab, Teaching and Learning Lab and also Research Lab. The enforcement of USECHH Regulation 2000 commonly took place in the industry, however the implementation of it in universities are still not widely accepted. The study was conducted by using audit checklist, questionnaire, on-site observation and interview based on seventeen requirements listed in USECHH Regulation 2000. The methodology was divided into four phases; (1) the quality control; pre-test survey phase, (2) the on-site data gathering information phase, (3) data evaluation phase, and (4) safety plan proposal phase. Among the three types of laboratory, Service Laboratory shows the best result. However one way ANOVA statistical test proved that there are no significant differences between each type of laboratory. The questionnaire results revealed that training, awareness and knowledge, and management support are the critical reasons that contributed to the compliance status of the laboratories. Involvement of students and lecturers, website and system development, and control of procurement are among the critical success factors to improve the enforcement of USECHH Regulation 2000 in the campus.

Keywords: Safety and health; USECHH Regulation 2000; chemicals; laboratory safety; University

1. INTRODUCTION

The main legal framework protecting safety and health of workers at work in Malaysia is the Occupational Safety and Health Act (Act 514) [1]. Under this Act, sub-regulation of Occupational Safety and Health (Use and Standard of Exposure of Chemical Hazardous to Health) Regulation 2000 [2] or in brief (USECHH Regulation 2000) was established on 4th April 2000, which provides a legitimate framework for the employers to control chemicals hazardous to health used in the workplace.

USECHH Regulation 2000 provides the compulsory actions need to be taken in order to minimize the risk of a chemical at the workplace. Schedule 1 in USECHH Regulation 2000 lists more than 600 hazardous chemicals and their permissible exposure limit (PELs). The other 34 hazardous chemicals mainly heavy metals and solvents are listed in Schedule 2, which if medical surveillance is required, it will be based on the Chemical Hazard Risk Assessment (CHRA) assessment [3]. The CHRA is an assessment that utilizes a systematic approach, starting from identification of hazards, the process and management of hazardous chemicals, hazard risk evaluation, control measures taken and finally determining the level of risk at the workplace [4].

The responsibilities of employers to protect occupational safety and health of their employees and related individuals are clearly stated in USECHH Regulation 2000. This regulation changes the employer's approach from reactive to proactive [1]. Table 1 summarizes the requirements in this regulation.

Universiti Teknologi Malaysia (UTM) is a public research university in Malaysia which is well known as a research-intensive university in engineering, science and technology. Here the use of chemicals is common among students, researchers and staff who's engaged in teaching, research and service analysis in the laboratory. This diversity in lab operations is a significant challenge when addressing safety management in this setting [5]. Those who work in the laboratory are exposed to a variety of hazards such as instant exposure to chemicals like solvent, alkali and acid during sample preparation and analysis, spillage of chemicals, fire and explosion. Laboratories in academic institutions normally use relatively smaller volumes of harmful materials as compared to industrial laboratory, which regularly needs huge amounts of hazardous substances for the scale up activities and development processes [6]. Even though the use of chemicals is in smaller volumes, the safety management aspect should not be neglected to protect the individual from the risk exposed.

Many studies have been done abroad to evaluate and study the impact of chemical laboratory safety enforcement in educational institution. In United States, OSHA Laboratory Standard is used as a baseline in educational institution such as schools, colleges and universities. A study by Hill and Robert [7] revealed that after the implementation of OSHA's Laboratory Standard which replaced the safety education for undergraduate students, most college/university graduates with degrees that involved laboratory subjects did not develop strong safety ethics and have not been properly educated in safety. Another study by Weil [8] stated that safety professionals have chosen ways to comply with the standard that suit their individual institution. However, from this study, the effectiveness of OSHA's Laboratory Standard implementation could not yet be confirmed.

Several studies from different countries also revealed the awareness level of chemical safety and enforcement at university level. Feszterová [9] studied about the importance of university teachers in Slovakia to have continuing education in the field of safety and health, especially in chemical laboratory. In developing countries like Philippines, a study by Eguna [10] identified that the biggest challenge faced by the universities to adhere with the regulations is the budgetary constrain. There was also a research conducted in Universitas Indonesia that determined laboratory compliance level among 51 laboratories in the campus.

The baseline survey research was conducted by Lestari [11] using a Chemical Health, Safety and Security Checklist developed from several international and local references.

Table 1: Summary of USECHH Regulation 2000 requirements

No.	Requirements	Regulations	No.	Requirements	Regulations
1.	Identification and record of chemical	5(1)	10.	Labelling and relabeling	20 and 21
2.	Chemical Register	5(2)	11.	Information, instruction, training and supervision of person.	22 and 23
3.	Ceiling Limit, Eight-hour time-weighted average, Compliance with permissible exposure limit using respirator.	6, 7 and 8	12.	Safety Data Sheet (SDS).	24 and 25
4.	Assessment of risk to health (CHRA)	9, 11, 12 and 13	13.	Monitoring of exposure at the workplace.	26
5.	Personal Protective Equipment (PPE)	16	14.	Health surveillance program.	27
6.	Engineering control equipment.	17	15.	Medical removal protection.	28
7.	Approved design specification, construction and commissioning of LEV equipment.	18(a)	16.	Warning sign.	29
8.	Tested by a registered professional engineer.	18(b)	17.	Record keeping.	30
9.	Records of engineering control equipment.	19			

However, in Malaysian universities, there are limited studies on chemical safety awareness and enforcement. Abdullah [12] in his study revealed that the current program of chemical safety and health among the first year engineering students at Universiti Sains Malaysia is encouragingly positive. Nevertheless, there are still rooms for improvement in order to increase the safety and health awareness level. The result obtained was quite similar with a study conducted by Ismail [13]. In her study, several criteria were assessed and the results show that majority of the respondents which were from science background were aware about laboratory safety in the faculty. However, the questionnaire distributed was developed based on a few general requirements in Occupational Safety and Health Act 1994, and not specifically assessing the holistic requirement listed in USECHH Regulation 2000.

There was a study that used USECHH Regulation 2000 as a parameter to determine the compliance level in the laboratory. The researchers, Suhaily and co-workers [1] stated that in managing chemicals, USECHH Regulation 2000 should be used as a baseline reference for laboratory safety and health practice. The compliance study was however conducted among industrial chemical laboratories in Lembah Klang only at that time, and not considering university laboratories.

The issue of safety is a wide-ranging and encompassing concept that are sometimes overlooked or even ignored in Malaysian universities [13]. Since there are limited studies on the implementation of USECHH Regulation 2000 in universities, and there is no data to indicate the level of implementation and awareness of the staff in universities, this study focused on the implementation and suggestions to adhere with the requirements in Universiti Teknologi Malaysia.

2.0 METHODS

A cross-sectional study was conducted by using audit checklist, questionnaire and on-site interview. This study was divided into four phases; (1) the quality control; pre-test survey phase, (2) the on-site gathering of information phase, (3) data evaluation phase, and (4) safety plan proposal phase. Figure 1 shows the roadmap of study in order to achieve the objectives.

2.1 Phase 1: Quality Control; Pre Test Survey

The pre-test survey was conducted to test the reliability and validity of the questionnaire and audit checklist. Both forms were distributed among 10% of a similar sample population. The participants were briefed about the purpose of this study and the significant of audit checklist and questions on the questionnaire.

2.2 Phase 2: On-Site Gathering Information

Eighteen chemical testing laboratories were chosen to participate in this research survey. Six of them are related to ISO accreditation Service Laboratory. Another six of them are without any qualification certificate, specifically teaching and learning laboratories while the remaining six laboratories are research laboratories. All six ISO and towards ISO

laboratories were automatically chosen to be part of this survey. Meanwhile, for Teaching and Learning Laboratory, and Research Laboratory, all of them contained high number of chemicals in the laboratory, and the activity of chemical testing actively occurs throughout the year.

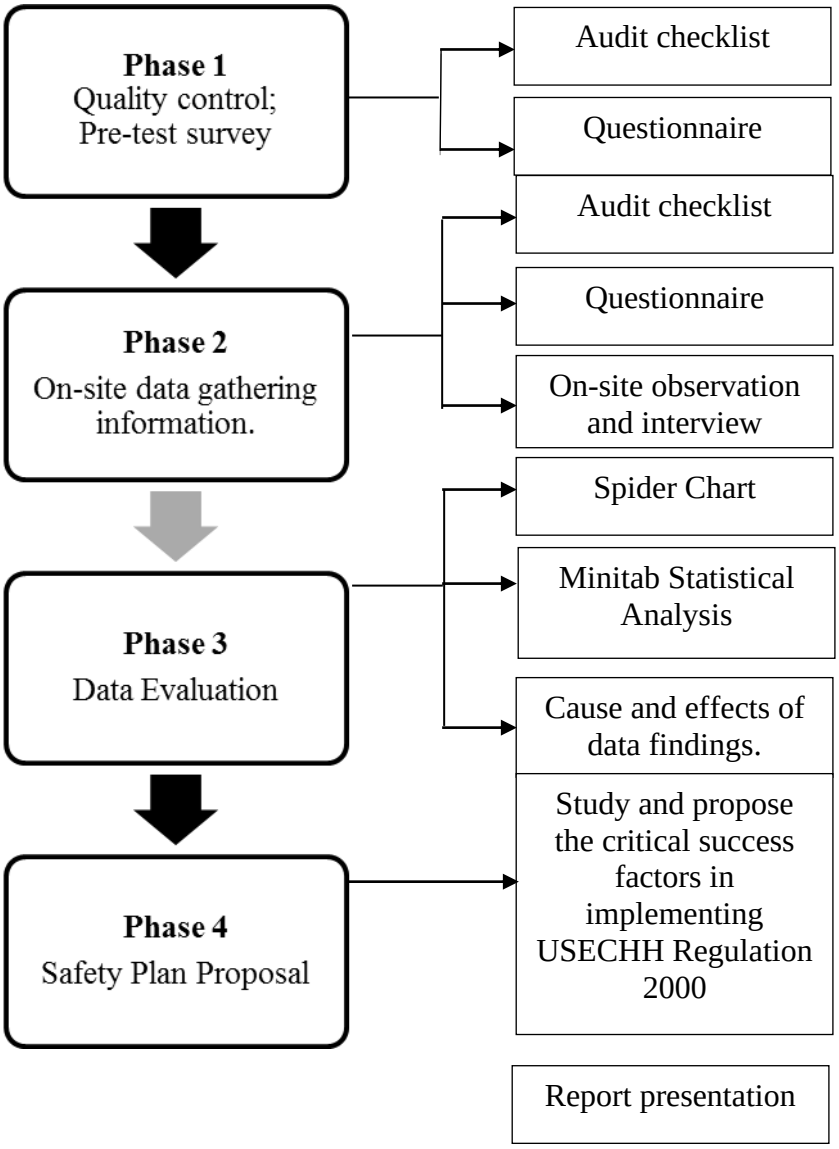


Figure 1: Roadmap of research design.

A total of 29 staffs and students were interviewed in this study. These include those who are directly in-charge of the laboratory and are responsible in managing the documents of the laboratory. The list of laboratories and the number of sample interviewed are summarized in Table 2. Laboratory observations and interviews of the staff were conducted. A briefing was first given to the staff involved to ensure they understand the requirements. An audit checklist constructed on the requirement listed in USECHH Regulation 2000 was used to indicate the compliance status.

Following the next objectives, to evaluate the hindering cause contributed to the implementation level of USECHH Regulation 2000 among chemical testing laboratories in UTM, questionnaire survey form was then distributed to the staff in the laboratories. The questionnaire focuses on eight criteria which are (i) safety culture (ii) awareness and knowledge (iii) communication (iv) training (v) management support (vi) reward (vii) attitude and (viii) employee involvement.

Table 2: List of UTM Laboratories

No.	Laboratories	Types of Laboratory	Status	Sample
1.	Lab 1	Service Lab	Accredited Lab	1
2.	Lab 2	Service Lab	Accredited Lab	3
3.	Lab 3	Service Lab	In Progress of ISO application.	4
4.	Lab 4	Service Lab	In Progress of ISO application.	2
5.	Lab 5	Service Lab	In Progress of ISO application.	2
6.	Lab 6	Service Lab	Not accredited.	2
7.	Lab 7	Teaching and Learning Lab	Not accredited.	1
8.	Lab 8	Teaching and Learning Lab	Not accredited.	1
9.	Lab 9	Teaching and Learning Lab	Not accredited.	1
10.	Lab 10	Teaching and Learning Lab	Not accredited.	1
11.	Lab 11	Teaching and Learning Lab	Not accredited	1
12.	Lab 12	Teaching and Learning Lab	Not accredited	1
13.	Lab 13	Research Lab	Not accredited	2
14.	Lab 14	Research Lab	Not accredited	1
15.	Lab 15	Research Lab	Not accredited	1

Table 2 *(Cont.)*: List of UTM Laboratories

No.	Laboratories	Types of Laboratory	Status	Sample
16.	Lab 16	Research Lab	Not accredited	1
17.	Lab 17	Research Lab	Not accredited	3
18.	Lab 18	Research Lab	Not accredited	1
			Total Sample Interviewed :	29

2.3 Phase 3: Data Evaluation

In this study, data to be collected also include the in-progress to comply status, which means laboratory that have the documents but incomplete, or prepared by the trained person instead of competent person. The compliance status was divided into three categories known as comply, shows progress and not comply.

For audit checklist, five marks were given to the laboratories that comply with each requirement. Three marks were given to the laboratory that shows progress to comply and zero marks for zero document and zero implementation on site. Total marks of each laboratory were counted for quantitative analysis.

The data are presented in spider chart and table form. To validate the significance of difference between categories of laboratory, the one-way analysis of variance (ANOVA) statistical test was calculated using Minitab 16.2 statistical software. For questionnaire, the ordinal data collected were calculated and were analyzed qualitatively using bar chart in Microsoft Excel.

2.4 Phase 4: Safety Plan Proposal

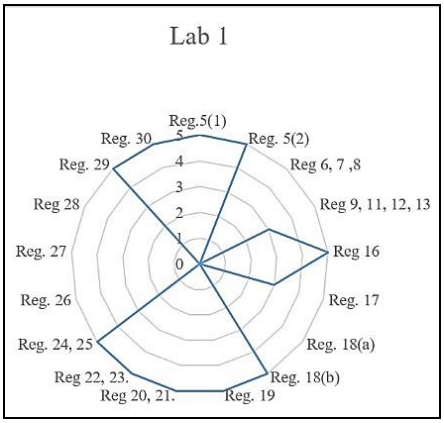
Based on the findings from data collected, the cause and effects were analyzed by comparing with the previous research recommendations and observation of the current situation on-going at the workplace. The final phase of this project was to propose a safety plan proposal. A progressive approach was designed to suit the requirements needed. The proposal consists of the critical success factors, recommendation and suggestion for improvement in terms of managing chemical safety to comply with USECHH Regulation 2000.

3.0 RESULTS

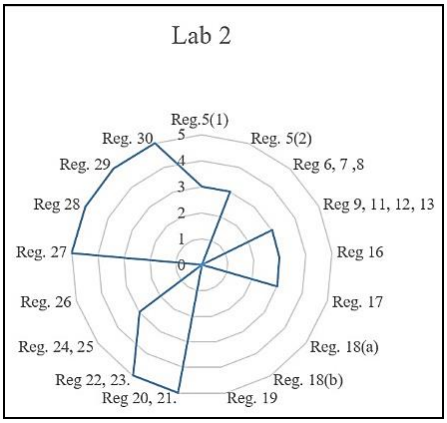
3.1 Compliance status towards USECHH Regulation 2000

The results of the audit checklist based on 17 requirements listed in USECHH Regulation 2000 are presented qualitatively using spider charts. In this study, none of the laboratories

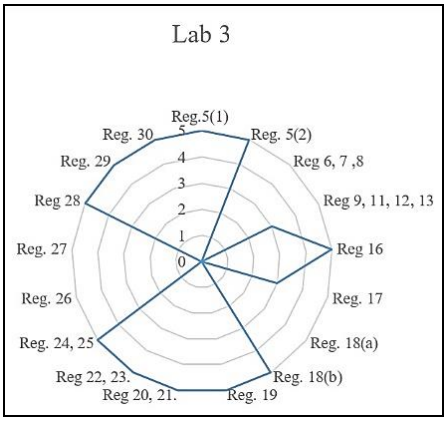
were able to fully comply with the regulations. Figure 2 illustrates the spider chart of Service Laboratory. Each laboratory shows different pattern, however most of them were able to comply with the Regulation 18(b) until Regulation 25. Among the Service Laboratories, three laboratories were able to comply with more than half of the requirements. The highest compliance was achieved by Lab 4 with 76%, followed by Lab 3 (65%) and 59% for Lab 1. Lab 3 and Lab 4 are in the same department, and show the best result compared to the other laboratories. Lab 1 has been audited previously by the university auditor in the Occupational Safety and Health Audit. The other two laboratories which are Lab 2 and Lab 5 showed weak implementation with only 35% and 29% of their chemical management respectively, were able to follow USECHH Regulation 2000, whereas Lab 6 failed to comply with all of the requirements.



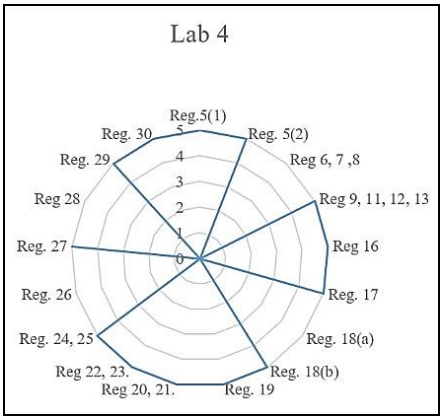
(a)



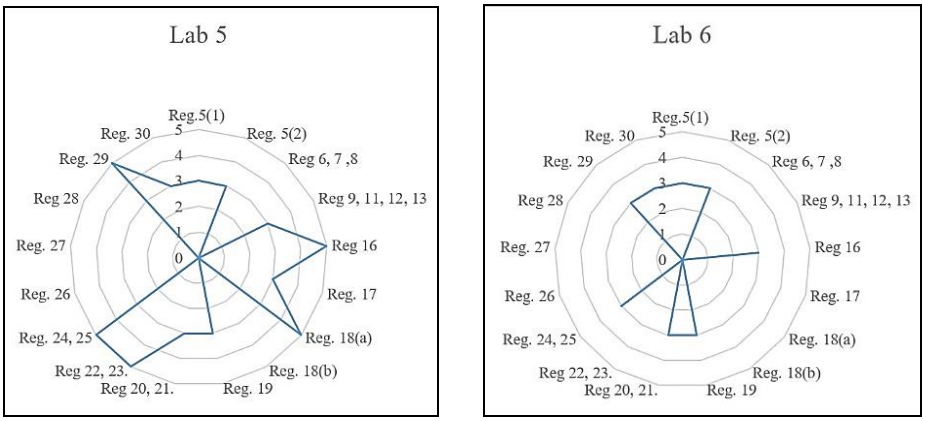
(b)



(c)



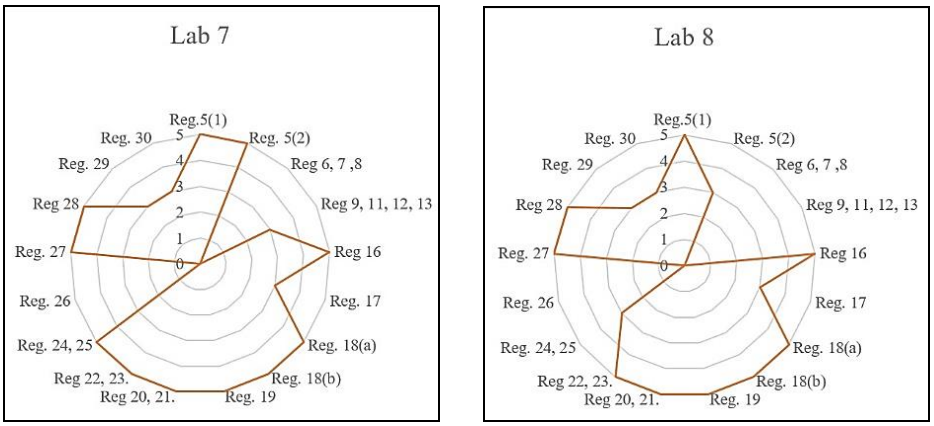
(d)



(e) (f)

Figure 2: Comparison of compliance status to USECHH Regulation 2000 among Services Laboratory in UTM.

Compliance status of Teaching and Learning laboratories are presented in Figure 3. In this study, all laboratories are from different departments. Most of the laboratories comply with Regulation 18(a) until Regulation 23. In this category, the percentages of compliance are lower than service laboratories. Lab 7 has the major compliance with 65%, followed by 53% for both Lab 8 and Lab 10. Lab 9 was only able to comply to about 35% of the regulations, Lab 12 with 29% compliance and Lab 11 failed to comply with any of the requirements.



(a) (b)

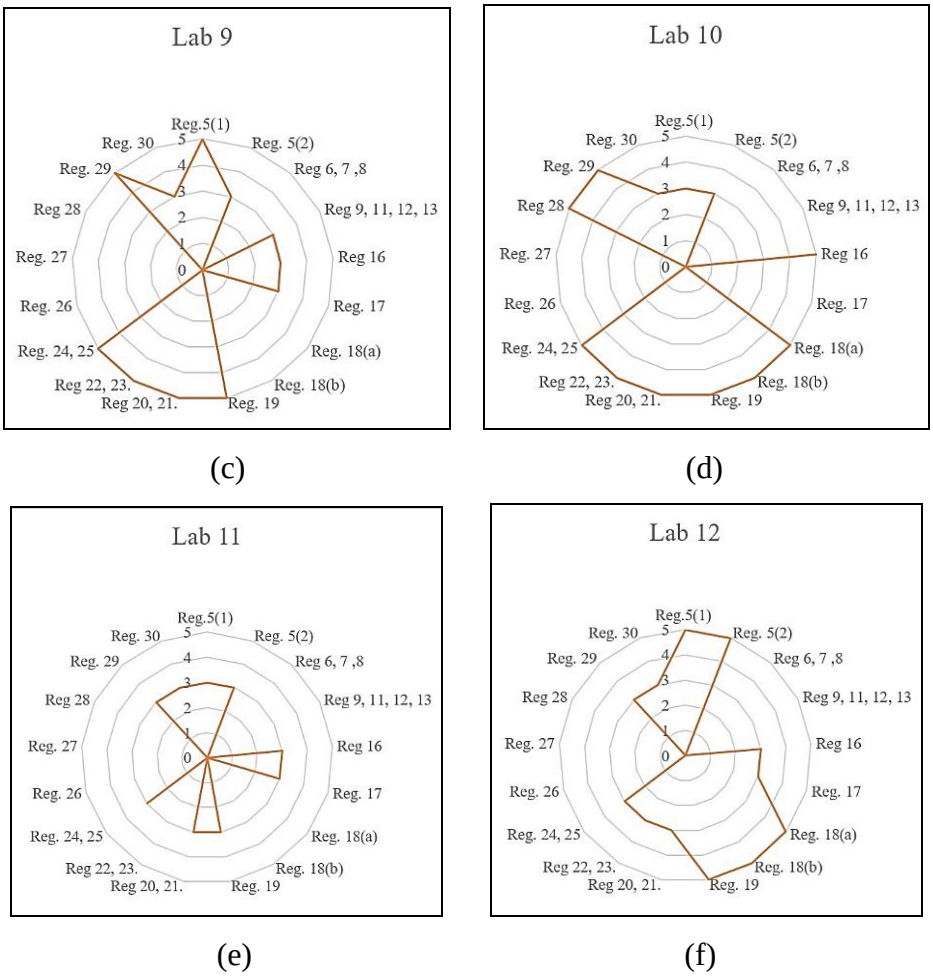


Figure 3: Comparison of compliance status to USECHH Regulation 2000 among Teaching and Learning Laboratory in UTM.

The result for the third types of laboratory, which is Research Laboratories are illustrated in Figure 4. The spider charts show that this type of laboratories has the weakest compliance among others. Only one laboratory which is Lab 17 was able to achieve 59% compliance. This is followed by Lab 16 with 47% compliance, Lab 14 with 35%, Lab 18 with 29% compliance and 18% compliance for Lab 15. Lab 13 failed to comply with all the requirements needed.

The compliance status between the three types of laboratories was then compared in Figure 5. Service laboratories show the highest compliance status with 44% performance, compared to 39% by teaching and learning laboratories, and research laboratories was only able to comply with about 31% of the requirements. Obviously, service labs have the best compliance performance among others, and a lot of improvements need to be done by research laboratories as they show the weakest compliance.

One-way ANOVA statistical test was conducted to examine whether there is significant difference between types of laboratory and their compliance performances. As shown in Table 3, p-value obtained was 0.757, which means that it can be assumed that there is no significant difference between types of laboratory.

Table 3: Analysis of relationship between types of laboratory and compliance status

Types of Laboratory	***n***	**Mean**	**Std. Dev.**	***p*-value**
Services	6	58.82	17.27	0.757
Teaching and Learning	6	58.63	16.43	
Research	6	52.55	15.40	

Results of further analysis are simplified in Figure 6 which includes all of the laboratories in this study. Percentage of laboratory complying with each requirement was calculated. Regulation 19, Regulation 22 and 23 show the same highest scores with 67% compliance. For Regulation 19, the inspection of engineering equipment carried out by Department of Safety and Health (DOSH) contributes to such high percentage of compliance. In Regulation 22 and 23, 67% laboratory complied but the remaining 33% was unable to show good progress or comply with the requirement. This is because some departments failed to identify the correct training needed by the staff due to lack of knowledge and understanding on the risk of the operation in the laboratory.

The worst compliance comes from Regulations 6, 7, 8, 18(a) and 26. For Regulation 6, 7, 8 and 26, none of the laboratories were able to comply or make progress with this regulation. Even though there were two trained hygiene technician one present in the campus, monitoring is quite difficult to do since it requires high cost of sampling equipment and laboratory service analysis with standard chemical industrial hygiene methods. On the other hand, most of the facilities come together with the building construction many years ago, where there is no concern on safety and health yet during the era. Some facilities do not even have the written documents on the specification and design installation thus explaining the reason of such result for Regulation 18(a).

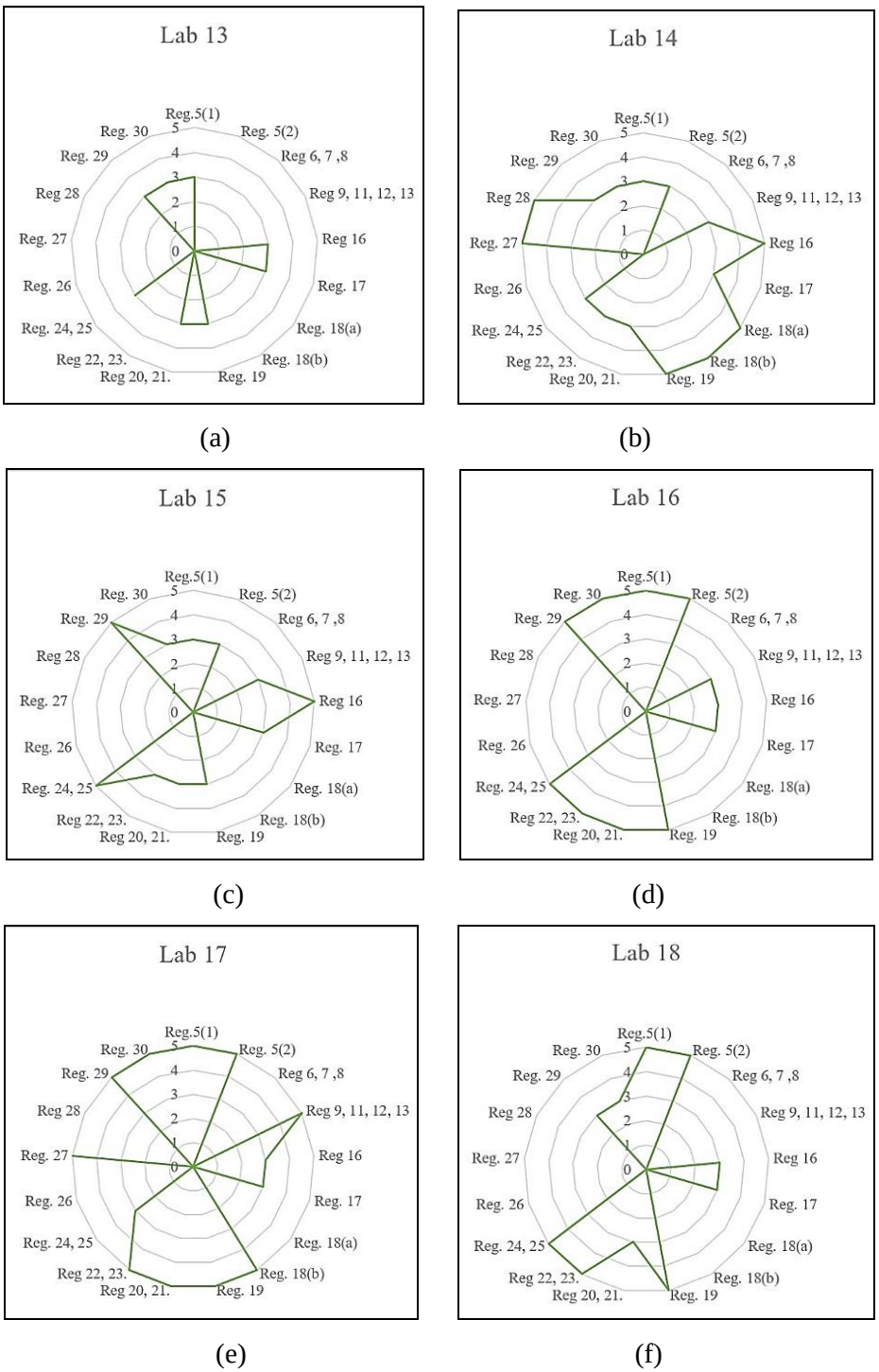


Figure 4: Comparison of compliance status to USECHH Regulation 2000 among Research Laboratory in UTM.

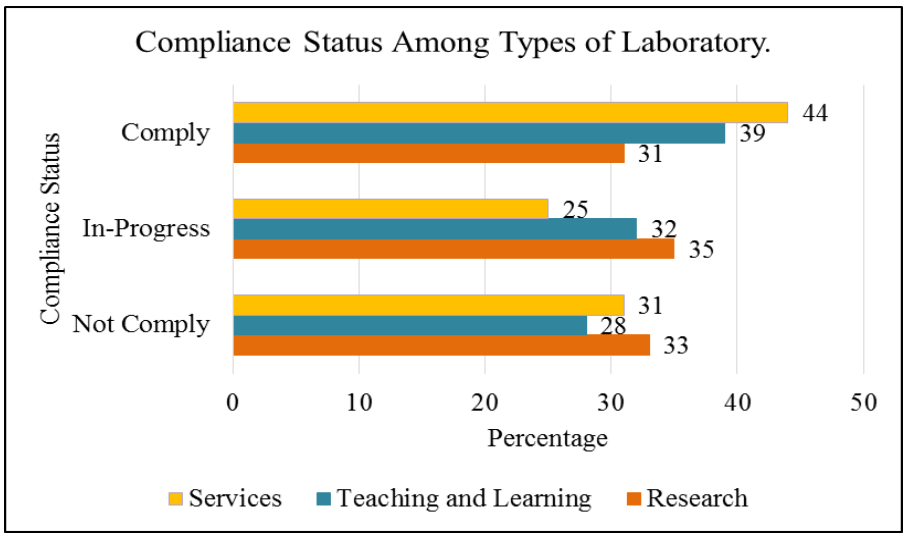


Figure 5: Compliance status among types of laboratory.

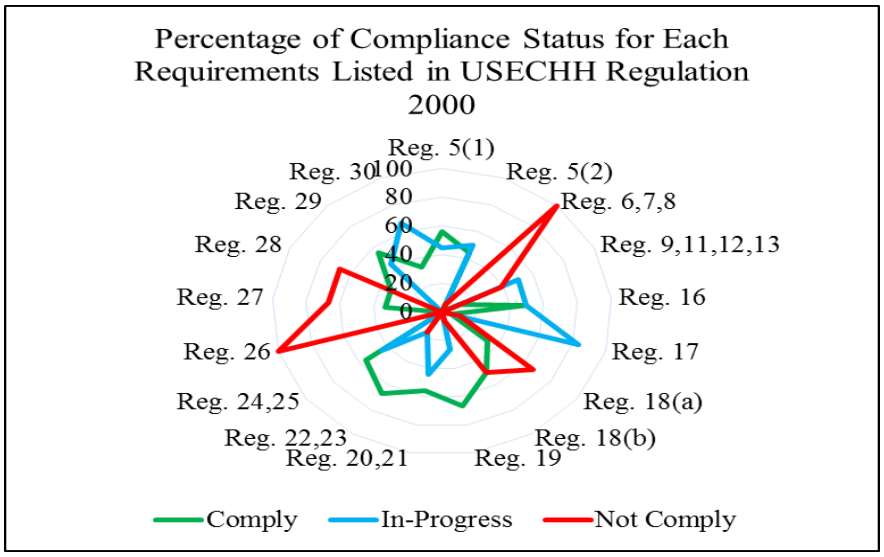


Figure 6: Percentage of compliance status for each requirement listed in USECHH Regulation 2000.

3.2 Factors contributing to the compliance status of the laboratories

Questionnaires distributed to the staff consist of thirty three questions considering eight factors, and the data obtained are presented in Figure 7. Service Laboratory staff scored the highest marks in seven out of eight factors concerning safety and health at the workplace.

Teaching and Learning Laboratory staff scored higher marks in those three main factors compared to Research Laboratory. Looking at the three main factors, the pattern of the marks scored tally with the compliance status ranking of the laboratories. From the graph, it can be concluded that the three factors contributed the most problems in terms of safety and health

compliance of university laboratories are (i) lack of training (ii) low awareness and knowledge (iii) weak management support.

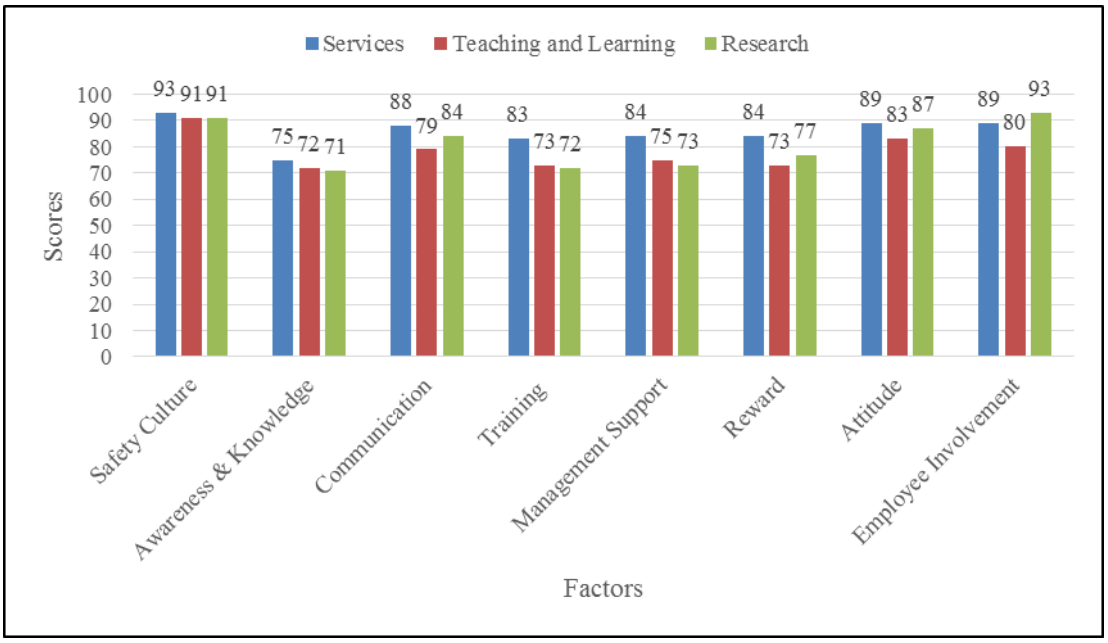


Figure 7: Factors contributed to the compliance status of the laboratories.

4.0 DISCUSSIONS

4.1 Background and operation of the laboratories.

Based on the results obtained, service laboratory has the highest compliance performance among others. Service Laboratory is the laboratory that provides paid analysis services to the researchers, not only for academic purposes but also available for industry. It commonly has more staff compared to other types of laboratory. Each staff has specific task and instruments under their responsibilities, thus the job scope and workloads can be equally distributed among them in the laboratory. The head of laboratory or key personnel is able to properly supervise the laboratory user. As mentioned by Schröder [6], lab supervisors in academic institution that are active in overseeing safety behavior in the laboratory, such as compliance with PPE, will result in lesser number of accidents in the lab.

The main objective of Service Laboratory is for income generation of the university. Extra fund from their income generation activities allows the Service Laboratory to organize and attend many training activities in order to improve their knowledge and awareness. Due to the accreditation requirement, the laboratories implement strict control of user, method and parameter in the laboratory, thus encouraging them to have a proper monitoring and documentation of the laboratories. All of the elements give extra opportunity for them to comply with the regulations.

Teaching and Learning Laboratory is the laboratory purposely used for practical and classes in which the users are among undergraduates and lecturers. Each Teaching and Learning Laboratory usually has only one or two staff to manage the whole laboratory. Their workloads are more focused on class and practical preparation, thus potentially overlooking the laboratory safety management. However, the lab personnel received more exposure through training, and with a better management support, Teaching and Learning Laboratory compliance is still higher than research lab.

The third type of laboratory, which is Research Laboratories are commonly used by postgraduate students, researchers and lecturers. What make it worst is that some of them do not even have any non-academic staff to manage the laboratory. Their nature of works deals with advanced and unknown chemical hazards due to the diversity of research activities. Schroder [6] in his study stated that researchers in academic institutions priorities tremendously on their research and often ignore or forget safety related issues concerning their students. Their main objective is to fulfil their research achievement and become ignorant about safety and health at their workplace. Lack of training with low support from the management explains it well on why they have the worst compliance among other types of laboratories.

This study also discovers the other main reason that often prevents the compliance of the regulation which is the budgetary constrain. In developing countries, budgetary constraints are perhaps more stringent compared to universities in developed nation. Due to that, chemical laboratory safety often becomes an afterthought in academic institutions [10]. It is compulsory for the universities to allocate fund for training and proper personal protective equipment (PPE) to the staff. Due to the financial constraint, safety concerns are left as the last priority.

4.2 Critical success factors to improve the implementation of USECHH Regulation 2000.

In view to the poor conditions of university laboratories, strategies to improve the USECHH Regulation 2000 implementation should be taken. Based on the study, seven critical success factors have been determined to navigate the implementation process. Firstly, it is important for the university to have the “safety champion” at both academic and management levels.. This champion should first come from the management level [14]. They should be able to manage safety training, safety talk, recruiting other members to assist in safety programs and could also spearhead the development of positive safety culture among faculty and staff members. The synergy of safety champions at both levels allow the university community to be educated holistically.

The second critical success factor is the promotion of Environment, Health and Safety (EH&S) services in the campus. As written by Mulcahy [15], their third approach to improve

the transparency of laboratory safety after the tragic accident in Texas Tech University is by promoting the visibility and implementation of their EH&S services. The activities include active discussion with research group, promoting services, answering surveys, practices and responsibilities to safety and health at workplace and also planning EH&S program for new faculty hires.

The third critical success factor is the establishment of public website and development of online system. A website should be used as a medium of communication, discussion, information and recommendation to UTM community. A progressive updates on the websites allow the staff, students and lecturers to use it as a reference. Other than that, the online system known as Laboratory Information Management System (LIMS) was used by UTM to manage the laboratory in the campus since 2012. The current developed system did not include the management of EH&S, however since 2017, LIMS undergo a holistic system upgrading development which covers all aspects of laboratory management. It is expected that this project will be completed on 2019 and will help a lot in improving USECHH 2000 implementation in the campus.

The next important factor is strengthening the role and responsibilities of safety committee. It is suggested that the membership comprises all ranks, undergraduates, graduate students, postdocs, technicians, lecturers, senior lecturers and professional person. This variety of experiences and responsibility can create effective initiatives in structuring ideas and activities not only related to chemical safety, but also other parts of safety management.

The final critical factor is the involvement of students and lecturers in training, course, seminar and programs. Hill [7] in his study revealed the continuous cycle of academic staffs that does not teach safety. This simply means that the teachers do not teach safety subjects formally in class or labs because it is not embedded in the curriculum. Graduates without proper safety education will not develop essential safety ethics. They will eventually become ignorant of safety when they later work in the industry.

In UTM, most of the faculties with laboratory-based programs do not make safety education as part of the syllabus. The consequences are quite obvious, where safety is not practiced as a priority but seen as a burden to the students and academic staff. Awareness program, chemical safety training, course and seminar always focus on the non-academic staff only. It is difficult for the non-academic staff to make improvement when there is no support from the academic staff and the students. Academic staff and students should have a strong basic knowledge in chemical safety, and not to depend on non-academic staff to be fully in-charge about the hazard and risk in their laboratory space. UTM can take a progressive approach by involving academic staff and students in training, course, seminar and program. Activities at the department/faculty level are more relevant and effective in reaching such group.

4.0 CONCLUSION

The objectives to analyze the level of USECHH Regulation 2000 implementations, to evaluate the hindering causes and to formulate significant critical success factors in order to improve the compliance have successfully been achieved in this research. Service Laboratory shows the best result among the other laboratories, however one way ANOVA statistical test proved that there is no significant difference between each type of laboratory. The questionnaire results revealed that training, awareness and knowledge, and management support are the critical reasons that contributed to the implementation performance. Five approaches are listed as the critical success factors to improve the enforcement of USECHH Regulation 2000 in the campus

Acknowledgement

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

References

[1] Suhaily, A., Norhafsam, M.M., Ahmad Sayuti, Z.A., Nor Husna, M.H., Naemah, T.A., & Nursuhairah, J. (2012). Laboratory OSH compliance status among chemical testing laboratory in Lembah Klang. *Journal of Occupational Safety and Health*, 9, 73-82.

[2] Occupational Safety and Health (Use and Standards of Exposure of Chemicals Hazardous to Health) Regulations, USECHH Regulations (2000). http://www.dosh.gov.my/index.php/en/legislation/regulations-1/osha-1994-act-154/522-pua-131-2000-1/file. Accessed on 22 March 2019.

[3] Rampal, K.G. and Mohd Nizam, J. (2006). Developing regulations for occupational exposures to health hazards in Malaysia. *Regulatory Toxicology and Pharmacology*, 46(2), 131-135.

[4] Husin, S.N.H., Mohamad, A.B., Abdullah, S.R.S. & Anuar, N. (2012). Chemical health risk assessment at the chemical and biochemical engineering laboratory. *Procedia – Social and Behavioral Sciences*, 60, 300-307.

[5] Mulcahy, M. B., Boylan, C., Sigmann, S. and Stuart, R. (2016). Using bowtie methodology to support laboratory hazard identification, risk management, and incident analysis. *Journal of Chemical Health and Safety*, 24(3), 14-20.

[6] Schröder, I., Huang, D.Y.Q., Ellis, O., Gibson, J.H. & Wayne, N.L. (2016). Laboratory safety attitudes and practices: a comparison of academic, government, and industry researchers. *Journal of Chemical Health and Safety*, 23(1), 12-23.

[7] Hill, Jr. & Robert, H. (2016). The impact of OSHA's laboratory standard on undergraduate safety education. *Journal of Chemical Health and Safety*, 23(5), 12-17.

[8] Weil, M. (2016). The laboratory safety standard at 25: Implementation of the standard through the Chemical Hygiene Plan and the Chemical Hygiene Officer – Is it trickling down? *Journal of Chemical Health and Safety*, 23(5), 31-40.

[9] Feszterová, M. (2015). Education for future teachers to OHS principles – Safety in

chemical laboratory. *Procedia – Social and Behavioral Sciences*, 191, 890-895.

[10] Eguna, M.T., Suico, M.L.S., & Lim, P.J.Y. (2011). Learning to be safe: Chemical laboratory management in a developing country. *Journal of Chemical Health and Safety*, 18(6), 5-7.

[11] Lestari, F., Budiawan, Kurniawidjaja, M.L. & Hartono, B. (2016). Baseline survey on the implementation of laboratory chemical safety, health and security within health faculties laboratories at Universitas Indonesia. *Journal of Chemical Health and Safety*, 23(4), 38-43.

[12] Abdullah, F. (2012). The relationship between chemical awareness and chemical safety among the first year students of engineering campus, Universiti Sains Malaysia. Universiti Utara Malaysia, Master of Science Thesis. http://etd.uum.edu.my/3571/7/s809051.pdf.

[13] Ismail, Z.S., Ariffin, K. & Aiyub, K. (2015). Promoting OSHA at higher Institutions: Assessment of level of safety awareness among laboratory users. Taylor's Business Review, *A Contemporary Business Journal*, 5(2), 155-164.

[14] Tsung-Chih, W., Chi-Wei, L. & Mu-Chen, L. (2007). Safety climate in university and college laboratories: Impact of organizational and individual factors, *Journal of Safety Research*, 38, 91–102.

[15] Mulcahy, M.B., Young, A., Gibson, J., Hildreth, C., Ashbrook, P., Izzo, R. & Backus, B. (2013). College and university sector response to the U.S. Chemical Safety Board Texas Tech incident report and UCLA laboratory fatality. *Journal of Chemical Health and Safety*, 20(2), 6-13.