FACTORS AFFECTING THE IMPLEMENTATION OF OCCUPATIONAL SAFETY AND HEALTH MANAGEMENT SYSTEM (OSHMS) IN MALAYSIA PETROCHEMICAL INDUSTRY

MOHAMMED MURAD AL-QAISI

A thesis submitted in
fulfilment of the requirement for the award of the
Degree of Master of Engineering Technology

Faculty of Engineering Technology
Universiti Tun Hussein Onn Malaysia

MAY 2022

DEDICATION

Firstly, I would like to appreciate Almighty Allah for his grace, guidance and protection during my master degree programme. I dedicate this dissertation with countless appreciation to my beloved father, mother and siblings who had supported me throughout my study.

ACKNOWLEDGEMENT

First and foremost, I would like to express my sincere gratitude and appreciation to Dr Rahim Bin Jamian who supervise me throughout my study. With his assistance and guidance, this study is accomplished and completed. I sincerely acknowledge his advice and encouragements. Moreover, my profound appreciation goes to Prof. Dr. Abdul Mutalib Bin Leman and all staffs in the Faculty of Engineering Technology at UTHM who were involved directly or indirectly in this project.

Furthermore, I would like to acknowledge to my dearest parents and siblings for their supports and uncountable love. Besides, I am extremely grateful to the respondents in my research. This research would not have been successful without the cooperation and information provided by them. Thank you for providing and sharing valuable information as guidance and essential resources needed in this research.

ABSTRACT

In petrochemical industries, a lot of attention has drawn on this sector due to its high incidence of accidents and fatality rates. Occupational safety and health management system (OSHMS) is essential for accident prevention, and successful implementation of OSHMS heavily depends on several items of contextual factors. Hence, this study was carried out to investigate the effect of 20 items of the independent variable (IV) with five items for each factor of management factor (MF), personal factor (PF), process factor (PRF), and environmental factor (EF) on four items of the dependent variable (DV) of OSHMS implementation in Malaysia petrochemical industry. A questionnaire survey was employed to obtain quantitative data from 150 respondents of the selected petrochemical companies. Then, the quantitative data analyses were performed through descriptive and inferential statistical methods. The validity of the questionnaire was confirmed based on the value of the content validity index (CVI). Besides, the loadings of five sub-factor model for MF, PF, PRF, and EF were statistically significant by conducting confirmatory factor analysis (CFA). Based on mean score results, the descriptive analysis revealed that the sub-factors of facility management (MF5), training (PF2), maintenance (PRF4), and environmental programs (EF5) were considered as the most influencing factors of OSHMS implementation. Meanwhile, the inferential statistical method using correlation and multiple regression analysis (MRA) was adopted to investigate the association between IVs and DV. There was a positive and very strong relationship between all the factors and OSHMS implementation based on the value of the Pearson correlation coefficient obtained. Therefore, this study concluded that these contextual factors should be taken into consideration towards achieving effective implementation of OSHMS, particularly in Malaysia petrochemical industry. Nevertheless, the results of this study are limited to the keywords used for the sub-factors of PF, PRF, and EF, where the sub-factors are explained using the keywords that related to MF activities, which could led to the source of the problem. The results could be more meaningful when the appropriate keywords are used within the sub-factors of MF, PF, PRF and EF.

ABSTRAK

Industri petrokimia kini mendapat reputasi yang meluas sebagai sebahagian daripada industri berbahaya disebabkan berlakunya kejadian kemalangan dan kematian yang tinggi. Sistem pengurusan keselamatan dan kesihatan pekerjaan (OSHMS) adalah penting untuk pencegahan kemalangan, dan kejayaan pelaksanaan OSHMS sangat bergantung kepada beberapa faktor kontekstual. Kajian ini mencuba untuk menyelidik pengaruh 20 item pemboleh ubah bebas (IV) dengan lima item bagi setiap faktor pengurusan (MF), faktor peribadi (PF), faktor proses (PRF) dan faktor persekitaran (EF) terhadap empat item pemboleh ubah bersandar (DV) bagi pelaksanaan OSHMS di industri petrokimia di Malaysia. Borang kajiselidik diedarkan untuk memperoleh data kuantitatif daripada 150 responden di syarikat petrokimia terpilih. Analisis data kuantitatif kemudiannya dilakukan melalui kaedah statistik deskriptif dan inferensi. Proses kesahan terhadap soalan kajiselidik telah dilakukan berdasarkan kepada nilai indeks kesahan kandungan (CVI). Manakala beban sub-faktor untuk MF, PF, PRF dan EF adalah ketara secara statistik melalui pelaksanaan analisis faktor pengesahan (CFA). Berdasarkan hasil skor min, dapatan analisis deskriptif merumuskan sub-faktor pengurusan fasiliti (MF5), latihan (PF2), penyelenggaraan (PRF4), dan program alam sekitar (EF5) dianggap sebagai faktor yang paling mempengaruhi pelaksanaan OSHMS. Sementara itu, kaedah statistik inferensi melalui analisis korelasi dan regresi diadaptasi dalam menyelidik hubungan antara IVs dan DV. Terdapat hubungan positif dan sangat kuat antara semua faktor dengan pelaksanaan OSHMS berdasarkan nilai pekali kolerasi Pearson yang diperolehi. Oleh itu, kajian ini membuat kesimpulan bahawa faktor-faktor tersebut harus diberi pertimbangan yang sewajarnya ke arah mencapai pelaksanaan OSHMS yang berkesan khususnya dalam industri petrokimia di Malaysia. Namun begitu, hasil kajian ini terhad kepada penggunaan kata kunci untuk sub-faktor PF, PRF, dan EF, di mana sub-faktor berkenaan dijelaskan menggunakan kata kunci yang berkaitan dengan aktiviti MF, di mana ianya boleh membawa kepada masalah sumber rujukan. Hasil kajian ini boleh menjadi lebih bermakna apabila kata kunci yang sesuai digunakan dalam sub-faktor MF, PF, PRF dan EF.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

DOSH	Department of Safety and Health, Malaysia
EF	Environmental Factors
FMA	Factories and Machinery Act
ILO	International Labour Organisation
MF	Management Factors
MITI	Ministry of International Trade and Industry
MNCs	Multinational Corporations
MPA	Malaysian Petrochemical Association
OSH	Occupational Safety and Health
OSHA	Occupational Safety and Health Act
OSHMS	Occupational Safety and Health Management Systems
PF	Personal Factors
PRF	Process Factors
SPSS	Statistical Package for the Social Sciences

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Research background

Annually, there are approximately 340 million non-fatal occupational accidents around the world (ILO, 2021). In recent years, Asian countries have become major contributors to these accidents, with two-thirds of global work-related non-fatal occupational accidents. In Malaysia, there are more than 3,000 work-related accidents reported and investigated by the Department of Occupational Safety and Health (DOSH) each year as depicted in Figure 1.1 (DOSH, 2020). The emergence of several occupational accidents and incidents has severely affected the productivity, efficiency and firm's performance in the past decades. Subsequently, the incidents have led to the progressive development of Occupational Safety and Health Management Systems (OSHMS) in various industries as an accident prevention mechanism (Jalonen, 2009).

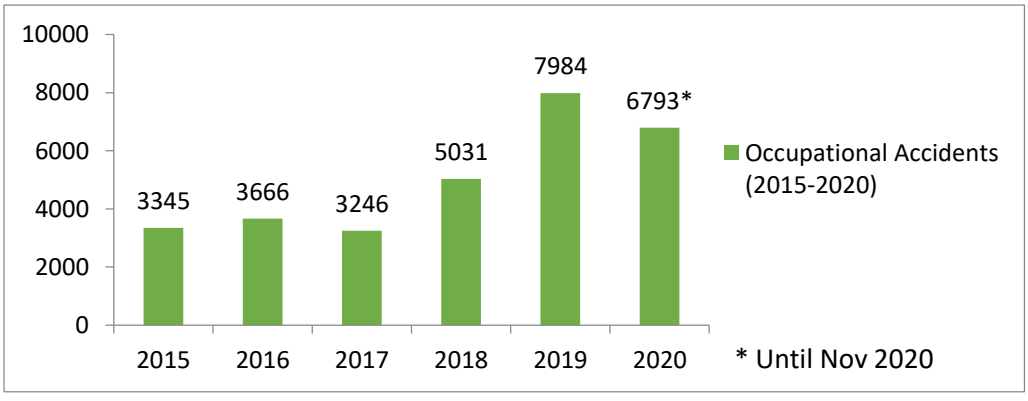

Figure 1.1: Occupational accidents statistics (2015 – 2020)
(DOSH, 2020)

Today, OSHMS has been presented as one of an effective way to prevent harm within the industry (Wenzel *et al*., 2013). The implementation of OSHMS is now a legal requirement in many countries. OSHMS has become an important part of management activities, both in public and private sectors. In the industrial sector, the emphasis of OSHMS has increased substantially. The major goal of OSHMS is to get rid of the initiation process that leads to accidents and incidents at the workplace. For instance, OSHMS is essential to successfully prevent accident in the manufacturing industries as it has become a matter for concern in the current age. Within the firm, OSHMS is often considered as complete elements and specifications of the overall administration framework that builds up or supports the policy, objectives and mechanisms to achieve those objectives in order to improve occupational safety and health (OSH) aspects (Joel *et al*., 2014).

The specifications of OSHMS define the components of this system for integrating with other management requirements and help achieve the objectives of OSH and economic objectives. The aim is to assist industries in providing functional OSHMS. The specifications specify the requirements of OSHMS, which can establish plans and frameworks that considered the legal needs and OSH hazards data. Furthermore, the OSHMS framework involves the evaluation and improvement of the execution within the avoidance of working environment, and mishaps through the viable administration of hazards. Nevertheless, this framework relies on several contextual factors such as the commitment of all activities of the establishment and its employees at all levels, particularly the commitment of senior management (Khor & Surienty, 2017).

The OSHMS is considered as a set of policies, strategies, procedures, measures, and controls applied to work activities in order to minimize risks and maximize safety (Haight *et al*., 2014). The utilization of OSHMS is concentrating on pertinent OSH criteria, measures and execution. Thus, maximizing the efficiency of firm performance in securing the work environment could be conducted through the establishment of effective controls to meet risks consistency with the policy and objectives of OSH. As prominently discussed in the previous studies such as Othman *et al*. (2015), Ghahramani (2016), Rojas *et al*. (2018), and Lee *et al*. (2020), the effective execution of OSHMS could enable getting rid of accidents in various industries including petrochemicals.

In many countries, petrochemical industries have recently received greater attention due to the high incidence of accidents and fatality rates (Othman *et al*., 2015). A series of overwhelming catastrophic occurrences include Mexico City (Mexico) in 1984 (Khan & Abbasi, 1999), Bhopal (India) in 1984 (Saraf & Karanjikar, 2005), Chernobyl (Ukraine) in 1987 (Rivkind *et al.*, 2020), Piper Alpha (UK) in 1988 (Swuste *et al*., 2018), Texas City (USA) in 2005 (Peek *et al*., 2009), Beirut (Lebanon) in 2020 (Radomska *et al*., 2020), and an acute chemical incident in Pasir Gudang (Malaysia) in 2019 (Mohd Farhan, 2019).

In the context of Malaysia, petrochemical companies are strongly encouraged by the government authority to be involved in OSHMS practices and comply with the Occupational Safety and Health Act (OSHA) 1994 towards reducing occupational injuries. Nonetheless, petrochemical industries are keen to adopt OSHMS practices in light of the increasing rigidity of the laws, protection of the working environment, adoption of economic policies, other measures, and important factors in support of OSH activities (Khor & Surienty, 2017). Therefore, there is an urgent need to explore the factors towards successful implementation of OSHMS in Malaysia petrochemical industry.

1.2 Problem statement

Safety is often referred to as a condition where an individual is protected against injury or loss. Industrially, accidents and injuries are caused mainly as the results of human errors concerning the physical condition or social environment (Pillay, 2015). The industrial incidents become worst over the years and seemed to be a major concern. Based on the reviews, there were a great number of occupational accidents and injuries occurrences. Occupational accidents and maladies are the foremost horrifying human catastrophe in the industry; it is one of its most genuine shapes of financial squander (Michael *et al*., 2009). Until 20 December 2020, 2100 work-related accidents are reported in Malaysian petrochemical industries (DOSH, 2020). The occurrence of accidents could be as results of the non-existence of OSH practices or inadequate understanding of influential factors within the existing OSHMS implementation (Othman *et al*., 2015).

Industries with OSHMS have challenges and obstacles related to their safety performance. This could be due to the lack of means or methods in establishing a

positive safety culture. Even though there is specific OSHMS practice; however, for several managers, there are inadequate economic incentives to enhance safety. For them, safety is not significantly encouraged at the forefront. Instead, the initial concern is profit, mission, productivity, or the growing strength of their businesses. Nevertheless, for some workers, controlling the dangers is the responsibility of only the management. They are reluctant to take a vital role in participating in OSH activities. Some of them even think that reporting OSH concern will cause them to be regarded as a troublemaker (Khor & Surienty, 2017).

Numerous studies have reported the importance of OSH measures (Varonen & Mattila, 2000; Alison & Vredenburgh, 2002; Silva *et al*., 2003; Ismail *et al*., 2012; Rundmo, 2017). These studies have investigated the implementation of OSHMS in various industries. Besides, several scholars have reported major failures in the implementation of OSHMS, even though there were endeavours to recognize its continuous improvement by considering several influencing factors. It would seem logical to believe that the implementation of OSHMS may be contingent on different contextual factors including management (Leung, 2000), personal (Knegtering, 2002), process (Hessman, 2012), and working environment (Carroll & Foster, 2011). Despite the reputation of petrochemical companies for being the most hazardous industry in many countries including Malaysia (Othman *et al*., 2015), the study is still lacking in the influencing factors and required to investigate the effectiveness of OSHMS implementation in petrochemical-based companies in Malaysia.

1.3 Research questions

This study sought to answer the following questions:

(i) What are the factors impacting the implementation of OSHMS in petrochemical industry?

(ii) What is the relationship between the contextual factors of management, personal, process and environment, and implementation of OSHMS in Malaysia petrochemical industry?

(iii) To what degree do the contextual factors influence the effectiveness of OSHMS implementation in Malaysia petrochemical industry?

1.4 Research objectives

This study evaluates possible factors affecting the effectiveness of OSHMS implementation in Malaysia petrochemical industry. Specifically, the objectives of the research are to:

(i) Identify the factors affecting the implementation of OSHMS in Malaysia petrochemical-based companies.

(ii) Examine the relationship between the contextual factors of management, personal, process and environment, and implementation of OSHMS.

(iii) Evaluate the factors influencing the effectiveness of OSHMS implementation.

1.5 Research scope

The scope of this research covers the parameters required for the implementation of OSHMS in petrochemical industries. In particular, the scope of the research work covers and focuses on, but not limited to the following:

(i) The petrochemical-based companies in this research study referred to the companies that produce petrochemical products; these companies contribute to the important national economic growth as classified by the Ministry of International Trade and Industry (MITI), Malaysia (MITI, 2015).

(ii) The involving participants for survey questionnaire are management staffs and employees of petrochemical companies in the petrochemical industrial zone in Pasir Gudang - Tanjung Langsat, Johor, since this industrial zone has a significant number of petrochemical companies (18 companies) out of a total number of the petrochemical industrial zone in Malaysia (40 companies).

(iii) The influencing contextual factors of OSHMS implementation in this research are emphasized on several notable aspects that have been prominently discussed in the literature, these are categorized into management, personal, process, and working environment.

1.6 Significance of research

The rationale for conducting this research is the concerns over the increasing trend of occupational accidents and incidents occurrence that have a significant impact on the protection and safety performance of workers in petrochemical-based companies. This research is significant because it will shade lights on how valuable OSHMS can make a difference in decreasing chances of danger or hurt at the workplace, particularly at petrochemical plants.

The findings on the relationship between the contextual factors and OSHMS implementation can benefit the academicians and researchers; could drive to crucial steps in conceiving and progressing consider on OSH gaps. Besides, the findings of this study can contribute to the improvement of theoretical information in handling safety execution and thus enhancing process safety performance in targeted petrochemical industries. Additionally, such analysis gives viable safety responsibility to the industrial shareholders. The research results would be shared to the related industries through the publication.

1.7 Organization of thesis

This thesis contains five main chapters. Chapter 1 provides the introduction of the research, which comprises background, problem statement, research questions, objectives, scopes, and significance of the study. Chapter 2 outlines the literature review, which focuses on petrochemical industry, occupational accidents, Occupational Safety and Health Management Systems (OSHMS), factors influencing OSHMS implementation, integrated management system and operation of OSHMS, and prominent study related to OSHMS in the industry. Chapter 3 explains the methodology used in this research, this includes research design, research framework, research data collection method, and research data analysis method. Chapter 4 reports the findings and analysis results, which include validity and reliability test, respondents' demographic characteristics, descriptive statistical analysis, confirmatory factor analysis, and inferential statistical analysis. Finally, Chapter 5 presents the discussion of the obtained results, summary and conclusion of research, and recommendation for future work.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter begins with an overview of the petrochemical industry, which comprises the global petrochemical industry and petrochemical industry in Malaysia. In the second part of this chapter, the description focuses on occupational accidents including industrial hazards and workplace accidents. The third part of this chapter emphasizes on the adoption of occupational safety and health management systems (OSHMS), which covers the elements of OSHMS, the impact of OSHMS on safety performance, and major concerns on OSHMS in the petrochemical industry. The fourth part discusses the factors influencing the practice of OSHMS in the context of management, personal, process, and environment. The fifth part presents the integrated management system and operation of OSHMS. The next part summarizes the prominent studies related to OSHMS implementation in the industrial sectors. Finally, this chapter ends with literature of previous findings on the considered topic.

2.2 Petrochemical industry

The petrochemical industry is often linking with the production and trade of petrochemicals. The industry is directly connected to the petroleum industry, especially the downstream sector. Typically, the downstream sector involves the refining of petroleum crude oil and processing of raw natural gas as well as the distribution of by-products of crude oil and natural gas (Chen, 2016).

Petrochemicals are chemicals produced from crude oil and natural gas distillation. The products resulting from petrochemicals include a polymer, resins, synthetic fibres, adhesives, paints, and coatings. In other word, petrochemicals can be

defined as a large group of chemicals derived from petroleum, natural gas; they are further used for a variety of chemical purposes which are highly significant in modern civilization and global economy (Cheng *et al*., 2013).

2.2.1 Global petrochemical industry

The petrochemical industry is competitive and requires major technological advancement; it is capital-intensive and operates in the global market for goods. The industry accounts for around 10% of the total petroleum industry in terms of production volumes. Because of the product values, the petrochemical industry accounts for a greater proportion of the overall industry, reflecting the higher value of petrochemical products compared to fuels. Nowadays, petrochemical industries are essential economy of developed and developing countries around the world including Malaysia.

2.2.2 Petrochemical industry in Malaysia

Petrochemicals industry is one of the primary industries in Malaysia. The development of this industry has been in great progress since the early 1990s. Currently, Malaysia is the main exporter of petrochemical products in the Southeast Asian region. As reported by Ministry of International Trade and Industry, Malaysia (MITI), the factors contributing to the development of the industry include the presence of 40 petrochemical companies in operation, with a combined capacity of 12.8 million metric tonnes per annum and a total investment of RM31.5 billion as at the end of 2014 (MITI, 2015). The industry covers petroleum, natural gas and petrochemical products. The range of petrochemical products includes:

(i) Commodity grade resins (polyvinyl chloride - PVC).

(ii) Engineering grade resins (acrylonitrile butadiene - ABS).

(iii) Petrochemical derivatives (ethylene oxide - EO).

(iv) Specialized and fine chemicals (food additive and pharmaceuticals materials).

The production of petrochemicals has been stimulated by the availability of natural gas as feedstock for the industry. In the production, naphtha obtained from the petroleum refining is being used. According to Malaysian Petrochemical Association (MPA), the Malaysian government and Petroleum Nasional Berhad (PETRONAS) contributed significantly to boost the development and production of the petrochemical industry by creating a conducive investment environment for the expansion of petrochemical industry within the industrial zones (MPA, 2018). Table 2.1 summarizes major petrochemical industrial zones and products manufactured in Malaysia (MITI, 2015).

Table 2.1: Major petrochemical industrial zones and products manufactured (MITI, 2015)

Industrial Zones	Core Products
Kertih, Terengganu	Ethylene, propylene, para-xylene, benzene and syngas
Gebeng, Pahang	Propylene and syngas
Pasir Gudang - Tanjung Langsat, Johor	Ethylene, propylene, benzene, toluene, xylene and butadiene

Most of the current companies are multinational corporations (MNC) or joint ventures; the multinational corporations provide technology for the production of petrochemical products. Most petrochemical plants have installed the latest equipment with distributed control systems, purification procedures, sewage treatment systems and process reaction kinetics. With the advancement of technology, the connection between petrochemical products and consumers is expected to increase in the future (MITI, 2015). Nevertheless, the challenges for the industry focus on the production of environmental-friendly products and reduce occupational accidents in the petrochemical companies' processing plants.

2.3 Occupational accidents

Worldwide, especially in low and middle-income countries, the number of occupational accidents and industrial hazards is increasing. Occupational accidents and industrial diseases are the consequences of workplace exposure to hazards (Cheng

et al., 2013). Therefore, it is clear that occupational accidents and industrial hazards are the main problems and must be properly managed.

2.3.1 Occupational accidents and industrial hazards

The International Labour Organisation (ILO) estimated that about 2.3 million people worldwide die each year due to work accidents or illnesses. This number is equivalent to more than 6000 deaths every day. There are approximately 340 million occupational accidents and 160 million victims of work-related diseases worldwide each year. In addition to this staggering number, 313 million accidents occur at work every year, leading to long-term absences. The cost of work-related accidents or diseases is very high and may have several serious direct and indirect impacts and consequences on the workers, their families' lives, and the company's financial status. (ILO, 2013).
Asia is the largest contributor, accounting for about two-thirds of the global work-related mortality, followed by Africa with 11.8%, and Europe with 11.7%. In Malaysia, more than 6,000 workers are involved in accidents that relate to work in 2016; this shows that employers in the country have low safety awareness (NST Business, 2017). The total number of accidents reported by all departments has significantly increased. As of November 2020, the Department of Safety and Health, Malaysia (DOSH) has investigated 6793 cases of occupational accidents. The top three industries causing accidents are manufacturing (including petrochemical) (4294), agriculture (969) and transportation (359) (DOSH, 2020).

Occupational accidents could be categorized into two types, namely individual accidents and organizational accidents. Reason (1998) defined the individual accident as an accident in which a specific individual or group is usually both an agent and a victim. Although the loss caused by a personal accident may be great; however, its spread is limited. In contrast, organizational accidents occur in organizations or subsystems involving multiple reasons with a large number of people being affected at different operating levels of the respective companies. The most critical difference between personal accidents and organizational accidents lies in the quality, quantity and types of defences, obstacles, and safeguards that protect people and assets from local operations hazards.

At the same time, a hazard can be defined as a change in a situation or a series of circumstances. These changes can lead to potential injury, disease or property loss,

or potential tasks, environment, circumstances or innate quality leading to adverse or harmful consequences (Wu *et al*., 2016). Occupational hazards caused by biological, ergonomic, physical, chemical, and psychological hazards exist in all employment fields including agriculture, manufacturing, construction, and service industries.

Numerous studies have highlighted the industrial hazards related to chemicals at the workplace in Malaysia. For instance, a study conducted by Arifin (1981) among workers in the manufacturing industries revealed they were exposed to the hazards of chemicals and radiation, which caused eyestrain, headache and eye diseases. In agriculture, farmers who had used pesticides complained of experiencing some form of illness such as drowsiness, headaches, skin irritation, and breathing difficulties (Sarok, 2012). In other study, workers in the textile industry are exposed to chemical hazards such as sulfuric acid, caustic soda, dichlorobenzene, hydrochloric acid, and pentachlorophenol (Thapa, 2018). Since the result of this study is to investigate the effects of exposure to occupational hazards that cause workers' suffering, hazard management should be the primary concern among employers, stakeholders and decision-makers to offer mitigation and preventive measures.

2.3.2 Occupational accidents in petrochemical industry

Today, the petrochemical industries are of vital importance in the economy of most of the developed countries. The products of such industries are a mixture of hydrocarbons derived from the oil, which may be in the form of a gas, liquid, spray, or solid; these can cause risks both to the health and safety of employees or to safety of the company. The petrochemical plants typically contain gaseous, liquid and solid materials. These substances can be classified in terms of risks to toxic substances, radioactive materials, explosive materials, flammable materials, oxidizing materials, narcotic substances, irritants, and carcinogens, which cause infertility and loss of some senses. Therefore, such plants containing the above-mentioned materials are considered to be at risk of leaking gases, fires or explosions (Chen, 2016).

Occupational accidents are the main health hazard. In 1994, work-related injuries caused about 335,000 deaths based on ILO report. The good news is that fatal accidents in most industrialized countries are on a downward trend. Today, work-related accidents have become a major concern in industries. Besides, manufacturing workers are facing several problems because they are involved in different operations

REFERENCES

Abidin, E. Z. & Rasdi, A. I. (2015). Occupational safety and health management system in Malaysia: Comparison between OHSAS 18001:2007 and MS 1722:2011. *International Journal of Public Health and Clinical Sciences*, 2(3), 23-32.

Alison, & Vredenburgh, A. (2002). Organizational safety: Which management practices are most effective in reducing employee injury rates? *Journal of Safety Research*, 259-276.

Alnashwan, M. *Developing Process Safety Indicators for Organizational Factors in Petrochemical Industries*. Doctoral Dissertation: 2015.

Amirah, N.A., Asma, W.I., Muda, S., Amin, A. and Him, N.F.N., 2019, January. Analysis of Individual Factors on Employees' Perception towards Safety Culture in the Malaysian Manufacturing Industry. In *1st Aceh Global Conference (AGC 2018)*. Atlantis Press.

Anuar, I., Zahedi, F., Kadir, A. and Mokhtar, A.B. (2008). Occupational safety and health management system (OSHMS) guideline compliance among medical laboratories in Klang Valley. *Journal of Community Health*, 14(1).

Ariffin, J. (1981). The position of women workers in the manufacturing industries in Malaysia. *Akademika*, 18, 73-86.

Awang, N., Baharudin, M.R. and Saliluddin, S.M. (2019). Occupational Safety and Health Management System (OSHMs): Perception and Safety Satisfaction among Employees in Certified Organisations in Klang Valley. *Int. J. Educ. Res.*, 7(7), 37-45.

Aziz, H. A., Shariff, A. M., & Rusli, A. R. (2016). Interrelations between process safety management elements. *American Institute of Chemical Engineers*, 14, 56-60.

Bakar, H. T. Siong, P. H. Yan, C. K. Kamarizan, Ali, M. W. Hassim, M. H. & Kamarden, A. H. (2017). Analysis of main accident contributor according to

process safety management elements failure. *The Italian Association*, 56, 991-996.

Benge, V. A. (2018). What factors can affect the manufacturing process? Retrieved on Nov 27, 2018, from https://smallbusiness.chron.com

Bevilacqua M, Ciarapica F. E. & Sanctis, I. (2016). How to successfully implement OHSAS 18001: The Italian case. *J. Loss Prevent Proc. Ind.*, 44: 31-43.

Bloomfield, Jacqueline, and and Murray J Fisher. 2019. "Quantitative research design." Journal of the Australasian Rehabilitation Nurses Association 22 (2): 27-30.

Boiano, J. M., Steege, A. L. and Sweeney, M. H. (2014). Adherence to safe handling guidelines by health care workers who administer antineoplastic drugs. *Journal of occupational and environmental hygiene*, *11*(11), 728-740.

Boileau, P. E. (2016). Sustainability and prevention in health and safety. *Industrial Health*, 54(4): 293-295.

Brown, T.A. (2015). *Confirmatory for Applied Research*. 2nd ed. Brand: Guilford Press.

Carroll, W. F., & Foster, A. B. (2011). Environmental Health and Safety Management System. In N. A. (US) (Ed.), Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards: Updated Version, 9-30.

Chen, M. (2016). Process safety knowledge management in the chemical. *American Journal of Chemical Engineering*, 4(5), 131-138.

Cheng, C. W., Yao, H. Q., & Wu, T.C. (2013). Applying data mining techniques to analyze the causes of major occupational accidents in the petrochemical industry. *Journal of Loss Prevention in the Process Industries*, 26(6), 1269-1278.

Choi J. W., Seok, J. Y., Lee, S. J., Kim, H. S., & Yang, H. S. (2004). A study on the revitalization of occupational health and safety management system for companies. *OSHRI*.

Cohen, J. (1992). Statistical power analyses. *Current Directions in Psychological Science*, 1(3), 98-101.

Creswell, John W., and and J. David Creswell. 2017. Research Design; Qualitative, Quantitative, and Mixed Methods Approaches. Michigan: SAGE Publications, Inc.

Davis, J. A. (1971). *Elementary Survey Analysis*. New Jersey: Prentice-Hall.

De Oliveira Matias, J. C. & Coelho, D. A. (2002). The integration of the standards systems of quality management, environmental management and occupational health and safety management. *International Journal of Production Research*, 40(15), 3857-3866.

Diekhoff, G. (1992). *Statistics for the Social and Behavioural Sciences*. Dubuque: Wm. C., Brown Publishers.

DOSH (Department of Safety and Health, Malaysia). (2018). *Quality, Occupational Safety and Health Policy*. Retrieved on Sep 29, 2018, from http://www.dosh.gov.my

DOSH (Department of Safety and Health, Malaysia). (2020). *Occupational Accident Statistics*. Retrieved on Dec 20, 2020, from http://www.dosh.gov.my

Endroyo, B. Yuwono, B. E. Mardapi, D. & Soenarto, A. (2015). Model of learning/training of occupational safety & health (OSH) based on industry in the construction industry. *Procedia Engineering*, 125, 83-88.

Esaki, K. (2013). Analysis of influence of price to customer satisfaction based on the prediction models. *Intelligent Information Management* (IIM), 93-102.

Fabiano, B., C. F. & Pastorino R. (2004). A study of the relationship between occupational injuries and firm size and type in the Italian industry. *Safety Science*, 42, 587-600.

Faisal, K. & Abbasi, S. A. (1999). Major accidents in process industries and an analysis of causes and consequences. *Journal of Loss Prevention in the Process Industries*, 12(5), 361-378.

Fernandez-Muniz, B., Montes-Peon, J. M. & Vazquez-Ordas, C. J. (2209). Relation between occupational safety management and firm performance. *Safety Science*, 47(7), 980-991.

George, D., & Mallery, M. (2010). *SPSS for Windows Step by Step: A Simple Guide and Reference, 17.0 update*. 10a ed. Boston: Pearson.

Ghahramani, A. (2016). Assessment of occupational health and safety management systems status and effectiveness in manufacturing industry. *Institute of Behavioural Sciences: University of Helsinki*, 1, 1-70.

Glendon, A. I. & Litherland, D. K. (2001). Safety climate factors, group differences and safety behaviour in road construction. *Safety Science*, 39, 157-188.

Grayham, & Rosario, A. (2000). The management of health and safety at work regulations. *The Journal of the Royal Society for the Promotion of Health*, 47-51.

Haight, J. M., Yorio, P., Rost, K. A. and Willmer, D. R. (2014). Safety management systems: Comparing content & impact. *Professional Safety*, 59(05), 44-51.

Hair, J. F., Black, W. C., Babin, B. J., Anderson, R. E., Tatham, R. L. (2010). *Multivariate Data Analysis*. 6th ed. New Jersey: Person-Prentice Hall.

Hale, H., Smit, R., & Leeuwen, A. V. (1998). Evaluating safety in the management of maintenance activities in the chemical process industry. *Safety Science*, 21-44.

Hawkins, Melanie, Gerald R Elsworth, Elizabeth Hoban, and and Richard H Osborne. 2020. "Questionnaire validation practice within a theoretical framework: a systematic descriptive literature review of health literacy assessments ." BMJ Open 10: 1-12.

Herzog, T. R. (1996). *Research Methods in the Social Sciences*. New Jersey: Prentice Hall.

Hessman, T. M. (2012). *Key Factors in Manufacturing Success*. Retrieved on Nov 28, 2018. https://www.industryweek.com

HSE (Health and Safety Executive). (2001). A guide to measuring health & safety performance. Retrieved on Jun 18, 2019 from https://www.hse.gov.uk

Hsu, C. C. & Sandford, A. B. (2007). The Delphi Technique: Making Sense Of Consensus . *A peer-reviewed electronic journal*, 12(10), 1-8.

Husin, A., & Jusoff, A. (2008). Management of safety for quality construction. *Journal of Sustainable Development*, 41-47.

Iavicoli, S., Rondinone, B. M., Marinaccio, A., & Fingerhut, A. M. (2006). Industrial health: To whom correspondence should be addressed. Review article research priorities in occupational safety and health: A review. *Industrial Health*, 44(1), 169-178.

ILO (International Labour Organization). (2001). *Guidelines on occupational safety and health management systems.* Geneva: ILO.

ILO (International Labour Organization). (2013). *Can better working conditions improve the performance of SMEs? An International Literature Review*. Geneva: ILO.

ILO (International Labour Organization). (2014). *Chemical Safety and the Environment*. Retrieved on Nov 27, 2018, from https://www.ilo.org.

Ismai, S. N., Rangga, J. U. Rasdi, I. Rahman, U. R. & Samah, A. M. (2018). Mobile apps application to improve safety and health knowledge, attitude and practice among university students. *Mal J Med Health Sci*, 14(SPI), 47-55.

Ismail, Z. Doostdar, S. & Harun, A. Z. (2012). Factors influencing the implementation of a safety management system. *Safety Science*, 50(1), 418–423.

Jalonen, R. & Salmi, K. (2009). Safety performance indicators for maritime safety management. *Literature survey. Espoo: Teknillinen korkeakoulu. Insinööritieteiden ja arkkitehtuurin tiedekunta. Sovelletun mekaniikan laitos. Sarja AM/9*.

Jannadi, & Bu-Khamsin, A. (2005). Safety factors considered by industrial contractors in Saudi Arabia. *Building and Environment*, 539-547.

Jilcha, K. & Kitaw, A. D. (2016). A literature review on global Occupational Safety and Health practice & accidents severity. *International Journal for Quality Research*, 10(2), 279–310.

Jilcha, K. & Kitaw, D. (2016). A literature review on global occupational safety and health practice & accidents severity. *International Journal for Quality Research*, 10(2), 279-310.

Khor, L. K. & Surienty, A. L. (2017). The strategic role of safety advice towards safety participation in OSHMS in Malaysian manufacturing firms. *Journal of Occupational Safety and Health*, 14(2), 23-43.

Kirchsteiger. (2002). Review of international industrial safety management frameworks. *Process Safety and Environmental Protection*, 277- 298.

Kline, R. B. (2015). *Principles and Practice of Structural Equation Modeling*: Guilford publications.

Knegtering. (2002). Work improvement and occupational safety and health management systems: common features and research needs. *Industrial Health*, 121-133.

Kogi, K. (2002). Work improvement and occupational safety and health management systems: Common features and research needs. *Industrial Health*, 40(2), 121-133.

Krishna, & Sekharaiah, A. (2015). Security features of user's for online social networks. *IITM Journal of Management and IT*, 51-58.

Lacey, J. & Jones, R. (2016). ISO 45001 and the evolution of occupational health and safety management systems. *IOSH*.

Landy, F. J. & Conte, J. M. (2010). *Work on the 21st century: An Introduction to Industrial and Organizational Psychology*. New York: Wiley.

Lee, D. H. (2018). The effect of safety management and sustainable activities on sustainable performance: Focusing on suppliers. *Sustainability*, 10(4796): 1-16.

Lee, J., Jung, J., Yoon, S. J. & Byeon, S-H. (2020). Implementation of ISO 45001 considering strengthened demands for OHSMS in South Korea: Based on comparing surveys conducted in 2004 and 2018. *Safety and Health at Work*, 11, 418-424.

Leung, K. T. *Factors Affecting the Planning and Implementation of Occupational Health & Safety Management System*. Master Thesis. The Hong Kong Polytechnic University: 2000.

López-Botero, C. and Ovalle-Castiblanco, A. M. (2016). Degree of implementation of occupational Safety and health management systems (OSHMS), in the metalworking industries of the south-central region of Caldas-Colombia. *Ingeniería y competitividad*, 18(1), 93-103.

Lu, C. S. & Yang, C. S. (2010). Safety leadership and safety behaviour in container terminal operations. *Safety Science*, 48, 123-134.

Lwanga, S.K., Lemeshow, S. and World Health Organization. (1991). *Sample size determination in health studies: a practical manual*. World Health Organization.

Marhavilas, P., Koulouriotis, D., Nikolaou, I. & Tsotoulidou, A. S. (2018). International occupational health and safety management-systems standards as a frame for the sustainability: Mapping the territory. *Sustainability*, 10, 1-26.

Mayze, B., & Bradley, L. (2008). Safety Culture: A Multilevel Assessment Tool for the Construction Industry. *Proc. of the Third International Conference of the Cooperative Research Centre (CRC) for Construction Innovation – Clients Driving Innovation: Benefiting from Innovation*. Gold Coast Queensland, Australia.

Michael, L., William, Z. & Piergiorgio, A. (2009). Occupational risk perception, safety training, and injury prevention: Testing a model in the Italian printing industry. *Journal of Occupational Health Psychology*, 1-10.

MITI (Ministry of International Trade and Industry, Malaysia). (2015). *MITI Report 2015*. Retrieved on Aug 14, 2019, from https://www.miti.gov.my

Mohd Farhan, S. (2019). Johor government investigating 30 chemical factories in Pasir Gudang. *The Star*. Retrieved on Jun 24, 2019, from https://www.thestar.com.my

MPA (Malaysian Petrochemicals Association). (2018). *Malaysia Petrochemical Country Report 2018*. Retrieved on May 25, 2019, from https://www.mpa.org.my

Muijs, D. (2011). *Doing Quantitative Research in Education with SPSS*. London: SAGE Publications Ltd.

Nathai-Balkissoon, M. (2016). Occupational safety and health management system implementation metrics. *The Journal of the Association of Professional Engineers of Trinidad and Tobago,* 44(2), 24-34.

Neal, A. & Griffin, M. A. (2002). Safety climate and safety behaviour. Australian Journal of Management, 27(1), 67-75.

Neal, A. & Griffin, M. A. (2006). Work Group and Individual Influences on Workplace Accidents. *Proc. of the 15th Annual Conference of the Society for Industrial Psychology*. New Orleans, Louisiana.

NST Business. (2017). The changing landscape of manufacturing sector. *New Straits Times*. Retrieved on May 25, 2019, from https://www.mpa.org.my

Osman, A., Khalid, K. & Alfqeeh, F. M. (2019). Exploring the role of safety culture factors towards safety behaviour in small-medium enterprise. *International Journal of Enterpreneurship*, 23(3), 1-11.

Othman, N. A., Jabar, J., Murad, M. A., & Kamarudin, A. M. (2015). Factors influencing safety management systems in petrochemical processing plants. *Journal of Technology Management and Technopreneurship*, 2(2), 27-39.

Peek, M. K., Cutchin, M. P., Freeman, D., Stowe, R. P. & Goodwin, J. S. (2009). Environmental hazards and stress: Evidence from the Texas City stress and health safety. *Journal of Epidemiology & Community Health*, 63(10), 792-798.

Pillay, M. (2015). Accident causation, prevention and safety management: a review of the state-of-the-art. Procedia Manufacturing: *6th International Conference on Applied Human Factors and Ergonomics (AHFE 2015)*, 3(1), 1838-1845.

Polit, D. F., & Beck, C. T. (2006). The content validity index: are you sure you know what's being reported? Critique and recommendations. *Research in Nursing & Health*, 29(5), 489-497.

Polit, D. F., & Beck, C. T. (2010). Generalization in quantitative and qualitative research: Myths and strategies. *International Journal of Nursing Studies*, 47(11), 1451-1458.

Polit, D., Beck, T., & Owen, S. (2007). Focus on research methods is the CVI an acceptable indicator of content validity. *Res Nurs Health,* 30, 459-467.

Poon, W. F., Ma, C. H. & Ho, K. L. (2000). Statistical analysis on factors in reducing construction site accident frequency rate in Hong Kong. *Proceedings of the 6th Annual Conference of the Australian and New Zealand Association of Occupational Health and Safety Educators*, 341-355.

Radomska, M., Madzhd, S., Cherniak, L. & Mikhyeyev, O. (2020). Environmental pollution in the airport impact area – case study of the Boryspil international airport. *Environmental Problems*, 2 (5), 76-82.

Rajaprasad, S. & Chalapathi, P. (2015). Factors influencing implementation of OHSAS 18001 in Indian construction organizations: Interpretive structural modelling approach. *Safe Health Work*, 5(6), 200-205.

Reason, J., 1998. Achieving a safe culture: theory and practice. *Work & Stress*, 12(3), 293-306.

Rhaffor, K. A., Saparuddin, N. S. & Maidin, W. F. (2014). *Employees' Perception towards safety and health practices in a small-sized organization*. Kuala Lumpur: UniKL MSI.

Ridhuan, M. Yahya, C. A. & Abdullah, A. K. (2018). Occupational health and safety reports: A comparative study. *Asian Journal of Accounting and Governance*, 10(1), 11-22.

Rivkind, N., Stepanenko, V., Belukha, I., Guenthoer, J. & Kenneth, J. (2020). Female breast cancer risk in Bryansk Oblast, Russia, following prolonged low dose of exposure to radiation from Chernobyl power station accident. *International Journal of Epidemiology*, 49(2), 448-456.

Robson, L. S. Cullen K., Bielecky, A. & Núñez, I. (2009). The effect of occupational safety legislation in preventing accidents at work: traditional versus advanced manufacturing industries. *Environment and Planning C: Government and Policy*, 27(1), 159-174.

Robson, L. S., Clarke, A. J., Cullen K., Bielecky, A., Severin, C., Bigelow, L. P., Irvin, E., Culyer, A. & Mahood, Q. (2006). The effectiveness of occupational health

and safety management system interventions: A systematic review. *Safety Science*, 45(3), 329-353.

Rojas, D. M., Mora, B. R. & Bolivar, A. G. (2018). Implementation of the occupational health and safety management system (OSHMS) in Colombian companies. *Contemporary Engineering Sciences*, 11(19), 4533 - 4540.

Rundmo. (2017). Associations between safety and contingency measures and occupational accidents on offshore petroleum platforms. *Scand J Work Environ Health*, 128-131.

Said, S. M., Said, F. & Halim, Z. A. (2012). Workplace injuries in Malaysian manufacturing industries. *J. Occu. Safety & Health*, 9, 1-6.

Saraf, S. & Karanjikar, M. (2005). Literacy and economic impact of the Bhopal gas tragedy. *Journal of Loss Prevention in the Process Industries*, 18(4-6), 274-282.

Sarkam, S. F., Shaharuddin, L. S., Za, B. M., Masdek, N. R. N. M., Yaacob, N. J. A., & Musramaini, M. (2018). Factors influencing safety performance at the construction site. *International Journal of Academic Research in Business and Social Sciences*, 8(9), 1057-1068.

Sarok, A. (2012). Occupational hazards in the workplace: A case of an electronic company in Sama Jaya, Kuching, Sarawak, Malaysia. *Asian Journal of Business Research*, 2(1), 8-18.

Sekaran, U, & Bougie, R. J. (2016). *Research Methods for Business: A Skill Building Approach*. New Jersey: John Wiley & Sons.

Shamim, M. Y., Buang, S., & Anjum, A. (2018). Implementation of safety performance framework (SPF) in process industries to avoid disasters. *International Journal of Automotive and Mechanical Engineering*, 15(1), 5022-5035.

Sheatsley, P. B., (1983). *Questionnaire Construction and Item Writing*. In Rossi, P. H., Wright, J. D., Anderson, A. B. (eds.). Handbook of Survey Research, Chapter 6. San Diego: Academic Press, Inc.

Silva, S. A., Lima, M. L. & Baptista, A. C. (2003). OSCI: An organisational and safety climate inventory. *Researchgate*, 5-15.

Singh, R. & Mangat, N. S. (1996). *Elements of Survey Sampling*. Dordrecht, Netherlands: Kluwer Academic Publishers.

Surienty, L. (2019). OSH Implementation in SMEs in Malaysia: The Role of Management Practices and Legislation: Volume II: Safety and Health, Slips, Trips and Falls. *Proceedings of the 20th Congress of the International Ergonomics Association*, 2, 650-671.

Swuste, P., Groeneweg, J., Van Gulijk, C., Zwaard, W. & Lemkowitz, S. 2018. Safety management systems from Three Mile Island to Piper Alpha, a review in English and Dutch literature for the period 1979 7 - 1988. *Safety Science*, 107, 224-244.

Thapa, D. (2018). Occupational hazards in the workplace: A case study on Patan Industrial Estate, Lalitpur. *ResearchGate*, June 2018, 1-23.

Tsai, Y. (2011). Relationship between organizational culture, leadership behaviour and job satisfaction. *BMC Health Serv Res*., 11(98): 1-9.

Varonen, & Mattila, A. (2000). The safety climate and its relationship to safety practices, safety of the work environment and occupational accidents in eight wood-processing companies. *US National Library of Medicine*, 761-771.

Wenzel, H. (2013). *Introduction to Industrial Safety and Life Cycle Engineering (1st. ed.)*. Vienna: VCE Vienna Consulting Engineers ZT GmbH.

Wilson, & Koehn, A. (2000). Safety management: problems encountered and recommended solutions. *Journal of Construction Engineering and Management*, 77-79.

Wu, T. C., Chen, C. H., Yi, N. W., Lu, P. C., Yu, S. C. & Wang, C. P. (2016). Hazard management dealt by safety professionals in colleges: The impact of individuals' factors. *Int. J. Environ. Res. Public Health*, 13(12), 1-14.

Yam, F., Wong, C. S., Hoong, C. Y. and Ebrahimi, M. (2017). Shaping the culture of safety through effective leadership in Malaysia. *Asian Culture and History*, 9(2), 1-15.

Yap, C. K., Peng, S. H. T. & Leow, C. S. (2019). Contamination in Pasir Gudang area, Peninsular Malaysia: What can we learn from Kim Kim river chemical waste contamination?. *Journal of Humanities and Education Development (JHED)*, 1(2), 84-87.

Yoon, S. J. Lin, H. K. Chen, G., Yi, S. Choi, J., & Rui, A. Z. (2015). Effect of occupational health and safety management system on work-related accident rate and differences of occupational health and safety management system

awareness between managers in South Korea's construction industry. *PMC*, 4(4), 201-209.

Yoon, S. J., Lin, H. K. & Chen, G., Yi, S., Choi, J. & Rui, Z. (2013). Effect of occupational health and safety management system on work related accident rate and differences of occupational health and safety management system on work related accident rate and differences of occupational health and safety management system awareness between managers in South Korea's construction industry. *Safety & Health at Work*, 4(4), 201-209.