

# Journal of Occupational Safety and Health

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# Introducing the Journal of Occupational Safety and Health

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The National Institute of Occupational Safety and Health (NIOSH) is delighted to announce the publication of Journal of Occupational Safety and Health (JOSH).

JOSH is devoted to enhancing the knowledge and practice of occupational safety and health by widely disseminating research articles and applied studies of highest quality.

JOSH provides a solid base to bridge the issues and concerns related to occupational safety and health. JOSH offers scholarly, peer-reviewed articles, including correspondence, regular papers, articles and short reports, announcements and etc.

It is intended that this journal should serve the OSH community, practitioners, students and public while providing vital information for the promotion of workplace health and safety.

Apart from that JOSH aims:

- To promote debate and discussion on practical and theoretical aspects of OSH
- To encourage authors to comment critically on current OSH practices and discuss new concepts and emerging theories in OSH
- To inform OSH practitioners and students of current issues

JOSH is poised to become an essential resource in our efforts to promote and protect the safety and health of workers.

## From the Chief Executive Editor

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Workplace safety is a priority. Much needs to be done to encourage employees, employers and industries to position occupational safety and health at the top of their agenda. The imperative focus is our commitment to take action; and make the necessary changes to ensure that safety is viewed as the “Top of Mind Awareness” for everyone.

The Journal of Occupational Safety and Health (JOSH), the first to be published in Malaysia, aims to boost awareness on safety and health at the workplace.

I would like to highlight the article titled “The Risk of Work-Related Musculoskeletal Disorder Among Business Service Centre Workers”. Work-related musculoskeletal disorder (WMSD) has become one of the occupational health issues in the industrial world including Malaysia. Epidemiological studies have shown that musculoskeletal disorders are widely prevalent among employees who work with computers. The purpose of this study was to identify whether the duration of visual displaying unit (VDU) usage could contribute to the risk level of WMSD in various body regions. A cross-sectional study comprising 300 workers was conducted among employees in a business service centre who are using VDU for their daily routine tasks. The results showed a high prevalence rate of WMSD and there was also statistically significant difference between the hours of VDU usage and the risk level of WMSD towards their body regions. This study also concluded that the risk level of WMSD increases according to the length of VDU usage duration.

It is our hope that the contents of the journal will be read and reviewed by a wider audience, allowing for a more vast academic base, while there should also be an increased cumulative experience to draw on for debate and comment within the journal.

We aspire that the journal will be advantageous to all readers, as our objective is to serve the interest of everyone across all industries. Prime focus will be on issues that are of direct importance to our everyday practices.

I would like to take this opportunity to personally welcome all our readers and contributors to JOSH (Vol 17, No 2). I am eager to receive more contributions from the Malaysian OSH community and also from elsewhere for our upcoming issues.

**Haji Ayop Salleh**  
Chief Executive Editor

# Consequence Modelling of a Potential Major Hazard Accident of Chlorine Gas Leakage in Water Treatment Plant

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**ABSTRACT:** *A loss-of-containment scenario in the chemical industry can be devastating, for both property and human life. Over the past, there have been many chlorine-related accidents reported in Malaysia. Chlorine is one of the most commonly used water disinfectants in water treatment plants and this toxic chemical can cause adverse impacts to human health and the environment. In this research, DNV PHAST 8.11 (Process Hazard Analysis Software Tool) a consequence modelling software was used to describe the consequence of a chlorine leak at water treatment facilities. The worst-case scenarios of chlorine storage listed in the Hazard Register will be analysed by using the mentioned software. A catastrophic rupture with a 5mm leak was chosen for the simulation. The results rectify that potential hazard could exist under an average weather condition. This study corroborates that an estimated of 7,677 lives within a radius of 3.2 km distance could be affected by a 10 ppm of chlorine exposure during day time. By taking into account on the individual risk contours (IRC) claiming on workers' continuous expose to chlorine leak up to a year, the findings have shown that the probability of fatality rate is 1.2 in a million. A buffer zone should be allocated beyond the accepted individual risk contour. It is recommended that the emergency response and execution team should be coordinated to the Plant Emergency Controller in ensuring all personnel are well-informed of emergency alarms on all sites and to perform a safe and orderly evacuation. A comprehensive Emergency Response Plan (ERP) for all sites should be developed in collaboration with government agencies such as Local Authorities, Fire and Rescue Department and Police Department.*

**Keywords:** *Chlorine, Consequences Analysis, Major Hazard, PHAST, Water Treatment Plant*

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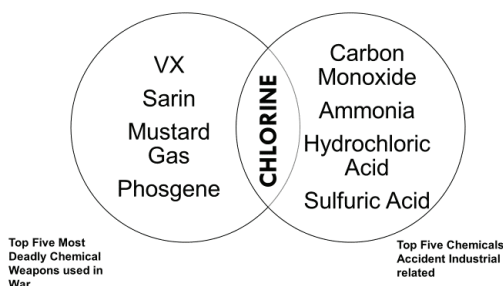
## 1.0 INTRODUCTION

A loss-of-containment scenario in the chemical industry can be devastating, for both property and human life. In the past, the world has witnessed numbers of Major Hazard disaster that cause thousands of lives perish (Khudbiddin et al., 2018; Drogaris, 1993; Christou, 1999). When toxic gas is released from the containment, it creates a cloud of gas that is heavier than air, and when it remains in contact with the ground as it dissipates, the condition will threaten people in its path. Chlorine gas is heavier than air when compressed and it can be extremely harmful to humans. Table 1 shows chlorine exposure thresholds and reported responses in humans (Oxychem, 2013)(White & Martin, 2010). The only chemical that are contributed A loss-of-containment scenario to industrial accident as well as used as chemical weapon is chlorine (Agency France-Presse, 2018; Dina Esfandiary, 2018) as shown in Fig. 2 below. There had been a few accidents of chlorine gas leak occurred in the industry which cause some damaged to property and human life (Law et al, 2018; Jimmy Goh, 2017; Iyuke et al, 2004).

**Table 1 Chlorine Exposure Thresholds and Reported Responses in Human**

Exposure level (ppm)	Effect
0.2 – 0.4	Threshold of odour perception with considerable variation among subjects
1 - 3	mild mucus membrane irritation
5 -15	moderate mucus membrane irritation
30	Immediate chest pain, vomiting, dyspnoea, and cough
430	Lethal over 30 minutes
1000	Fatal with a few minutes

In the context of Malaysia, several incidents of chlorine leaks have occurred in the past 2 years. On September 18, 2016, a chlorine concentration of up to 3 ppm was detected in chlorine gas leaked at the Bukit Merah Industrial Park from a Chlor-alkali plant, which triggered by a breakdown and collapse of a ferric acid reservoir. All workers of the plant were evacuated immediately. Two workers were hospitalized and one of them was diagnosed with pneumonia and was treated in the intensive care unit. One fireman suffered breathing difficulty, dizziness and red eyes during the rescue mission while some of the residents around the plant suffered irritation to eyes, nose and throat (Law et al, 2018).



**Figure 1 Similarity of Hazardous Chemical Use in War and Industry**

On July 21, 2017, a chlorine leakage incident reported at the Water Treatment Plant in Kota Belud, Sabah. As discovered the ruptures in one of the valves connected to the chlorine drum was a leak and it has caused a small amount of chlorine to escape. The personnel from the plant has stopped the leaks by securing the valve instantly. No injured were recorded in this incident (Jimmy Goh, 2017). In another incident happened on September 28, 2017, involved illegal dumping of chlorine drums close to the residential area at Kampung Tambak Paya, Melaka. The situation has caused fifty residents hospitalized, including four firemen. The dispersion of the chlorine cloud was within 1 km in radius from the disposed of the drum. Most of them suffered from breathlessness (Koh, 2017). On another incident that occurred at the Kg Tudang Water Treatment Plant, Kuala Kerai, Kelantan at around 11:35 a.m. on July 4, 1997, a case whereby chlorine gas leaked from one of the cylinders inside the chlorine room. The leak was caused by 1–2 mm hole at the bottom of 68 kg chlorine cylinder cause more than 79 people were examined at the local hospital for respiratory distress caused by chlorine exposure and 20 of them were admitted for further treatment (Iyuke et al, 2004).

It is significant that the recent incident of chlorine leaks has caused a severe impact on both the plant workers and nearby residents. It can also be being observed from these incidents that the chemical processing industry is prone to accidents because many chemicals are used in the operation process. These scenarios often exposing oneself to process hazards and lead to higher risks. As an apropos remark on the research study on Water Treatment Plant (WTP), the growing of water demand in an area tends to lead to an increase of chlorine used in the plant. The plant began in 1982 with the capacity to produce clean water for approximately 545 million litres of water per day (MWA, 2016). The plant currently produces 600 mld –caters for a higher demand for clean water. Higher output means more chlorine being used daily. In order to balance and sustain the supply and demand needs, huge numbers of chlorine need to be stored on-site to ensure indestructible supply to support the process. As an estimate quantity of 60 – 80 tonnes of chlorine are kept at the Water

Treatment Plant storage area. According to a desk study, the plant is situated near to the government administration building and residential area in Putrajaya.

The consequences analysis model is important to be inferred as to ensure corrective measures can be applied to prevent such a major hazard accident occurring. DNV, GL PHAST, software is used to perform consequences modelling. This kind of application makes things easy, it helps safety professionals to calculate and analyze the effects of these scenarios and subsequently develop the right prevention or containment protocols (DNV, 2018). Thence, DNV PHAST 8.11 is put to use in this study to evaluate the consequences of a chlorine leak at Water Treatment Facilities.

## 2.0 METHOD

### 2.1 Research Framework

The framework of this study has been established based on the background of the study. The objective of the research study, literature review and issues are identified accordingly. The framework and the flow of the study shown in Fig. 2. will be used as a guideline.

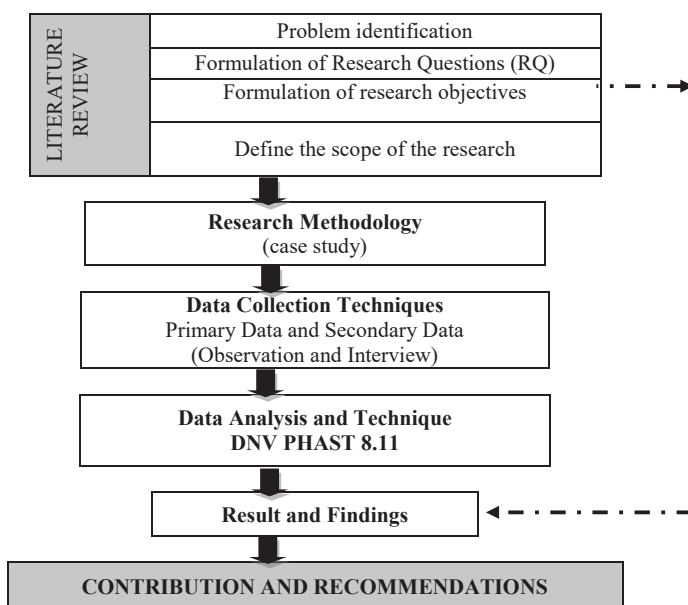


Figure 2 Research Framework

### 2.2 Data Collection

The data collected in this study can be divided into two categories which is the primary data and the secondary data. Primary data refers to data obtained from observation and interviews. These observations and interviews are used to identify potential risks that may arise when chlorine is stored in a water treatment plant. In adjunction, the secondary data is a general description of the processing path such as standard operating procedure (SOP), number of workers, the volume of hazardous materials used and stored, chlorine process flow and control system and certainly the emergency detection that has been installed on the site. Secondary data will be used in the consequences analysis.

Hazard identification and assessment are performed to foreshadow catastrophic failure on hazards and risks that could potentially triggered by chlorine leakage. The process of chlorination is dependent on properties and parameters such as pressure, temperature, and phase change. It is essential to understand the chlorine release phases in order to prioritize the loss of containment condition by projecting the most severe and more likely to occur scenarios. A risk assessment matrix could be used to support in determining the risk level. The matrix provides a quick view of both the likelihood and the severity of consequences. For each risk and hazard, control measure can be formulated or at least to reduce it. There are five stages in control measures: elimination, substitution, engineering controls, administrative controls, and the use of personal protective equipment. Once the scope of the study is defined, an Event Tree Analysis (ETA) will be established to determine the probability of hazard occurrence by referring to the frequency of the accident that has been recorded from the literature, incident statistics of the manufacturing plant, experiences of employees and historical data of incidents occur from various sources which internationally recognized. ETA is used in this study to identify and evaluate each of the sequences of events in predicting the potential accident scenario through screening at the occurrence of an initiating event.

### 2.3 Consequences Modelling Analysis

Based on the hazardous substance criterion, source modelling, the effect of chemical release and consequences event are predetermined. Three scenarios were chosen for the studies, vapor phase release, liquid phase release and catastrophic rupture on containers. The phenomenon is described by a hypothetical case of chlorine release from the Water Treatment Plant located in Putrajaya. The accidental release was due to leakage in a chlorine drum with approximately 930kg of chlorine was directly released into the atmosphere from the drum through a circular hole with a diameter of 5mm catastrophic rupture. The diameter of the cylindrical drum is measured at 0.78 m and with a total length of 2.08 m. The air temperature is 30°C, and the wind is travelling with a speed of 2 meters per second. After the direction and the mean of the studies are defined, the Event Tree Analysis (ETA) is applied to reckon the scenarios taking into account all possible failure modes. ETA is used in this study to determine the pathway to creating the biggest probability and frequency of failure for the specific system. Risk identification is the first process in determining risks that pertaining to multiple resources such as literature reviews, statistic reports from manufacturing plants, employee's knowledge and experiences, historical data of incidents recorded from international publications, etc. ETA is used in identifying and evaluating the sequence of events in causing a potential accident by focusing on the occurrences and severity of an initiating event. Record for speed of the wind is retrieved from the Malaysian Meteorological Department whereby the nearest meteorological station from the site would be KLIA Sepang. The study phase considers two different wind blow and its direction has been perceived as the major concerns. As observed, the highest percentage of wind blow is orientated from the northern and the second-highest wind blow was orientated from the northeast as it illustrated in Fig.3. The information and data were then analyzed by using the mathematical model or refer as QRA software. PHAST 8.11 is also applied to this research study. As for pasquill stability classification, Class B is referring to stability at day time while class F is referring to night time. Two different stabilities were chosen because the population at surrounding area are different in comparing to day time and night as the numbers of risk varies according to time changes. Both the stabilizer was selected in concert with the weather at a specific location to support the studies.

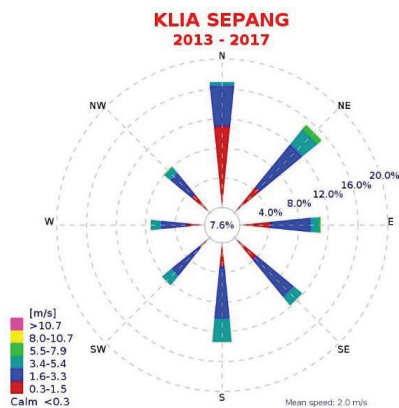


Figure 3 Windrose for KLIA Sepang Station from 2013-2017

### 3.0 RESULTS

#### 3.1 Hazard Register

The potential danger is dependent on the combination of hazardous material and the complexity of the process that counts in different sizes of equipment used in the processing unit. The total amount of hazardous material used as well as the danger processes or activities in the chlorine storage area are defined and simplified in Fig. 4. The hazard register is a record where all chlorine-related operational hazards are listed as a point of reference.

#### 3.2 Toxic Release Consequences Modelling

The result computed by PHAST 8.11 is summarized and tabulated in Table 2 below. The findings reflect on the worst outcome of a chlorine leak at a concentration of 10 ppm. Chlorine released in water treatment plants has led to a total rupture. The results indicated that the chlorine cloud dispersion could extend up to 3.2 km from F source under atmospheric conditions. Meanwhile for atmospheric condition class B in the same scenario, the chlorine concentration of 10ppm could reach as far as 545m. For 5mm liquid leak, at 10 ppm of concentration, the chlorine disperses as far as 3 km from the source for atmosphere stability class F but as for class B, under a similar criterion with 10 ppm chlorine concentration, the dispersion could have gone as far as 467.1 m. As for the 5mm vapour leak, the consequences are less compared to catastrophic rupture and liquid phase leak. The distance for 10 ppm of concentration for stability F is 914m while for stability B the distance is 144.6m.

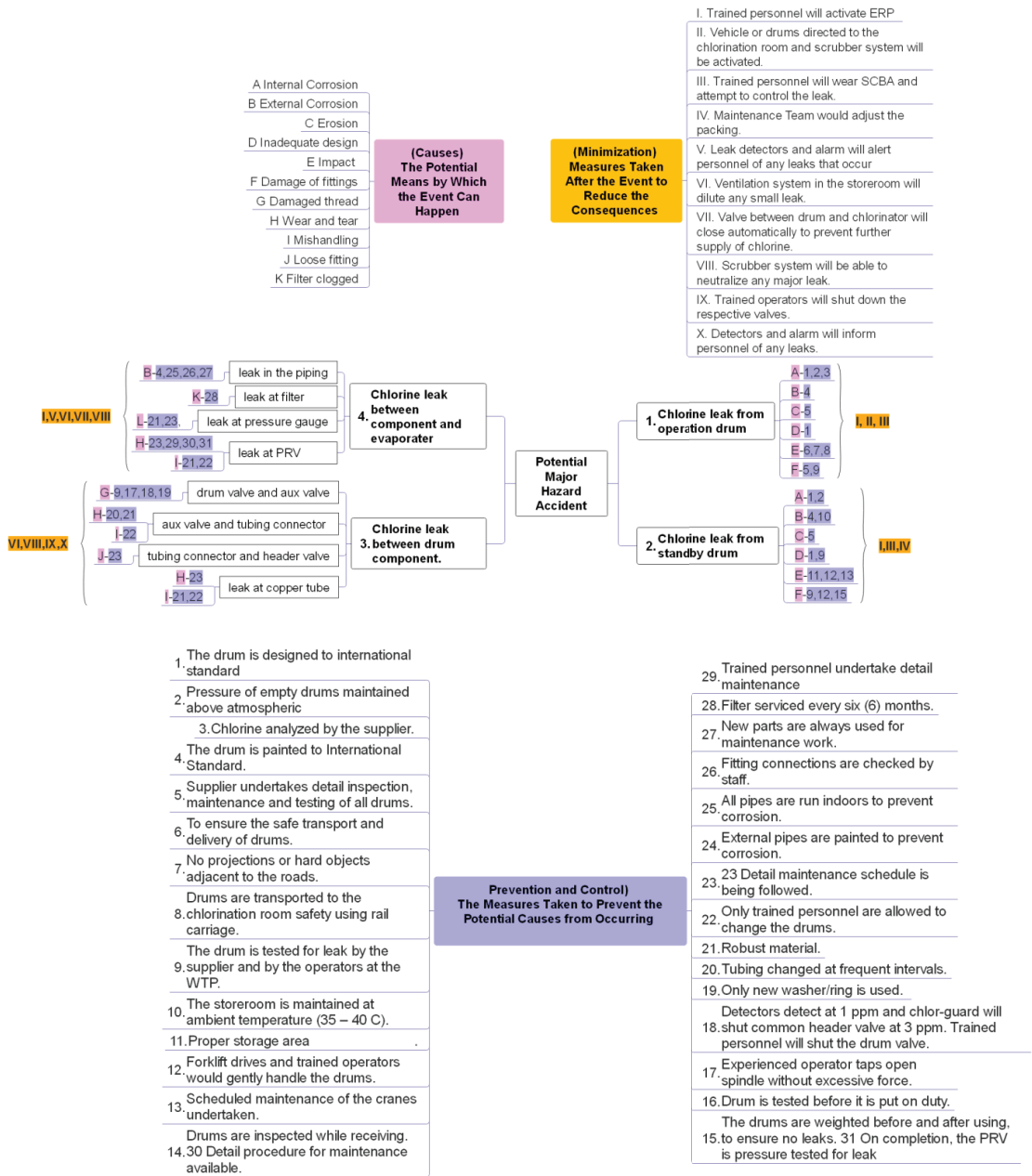


Figure 4 Simplify Hazard Register



**Table 2 Downwind Distance for Different Level of Concentration**

Scenario 1: Vapour phase release					
Release Rate = 0.06 Kg/s					
Level of Concern (LOC)	10 ppm	50ppm	100ppm	500ppm	1000ppm
Distance from source at stability class B(m)	144.6	64.7	47.0	26.9	17.4
Distance from source at stability class F(m)	914.97	289.1	157.7	27.2	16.3
Scenario 2: Liquid phase release					
Release Rate = 0.6Kg/s					
Level of Concern (LOC)	10 ppm	50ppm	100ppm	500ppm	1000ppm
Distance from source at stability class B(m)	467.1	195.6	136.3	68.3	56.6
Distance from source at stability class F(m)	3007.7	1008.2	593.5	146.0	85.4
Scenario 3: Catastrophic Rupture					
Release Rate = Sudden release					
Level of Concern (LOC)	10 ppm	50ppm	100ppm	500ppm	1000ppm
Distance from source at stability class B(m)	545.0	228.8	160.3	82.4	68.9
Distance from source at stability class F(m)	3220.0	1132.0	672.2	170.1	101.5

### 3.3 Effect on People On-Site and Off-Site

By accepting the meteorological circumstance, the most wind direction throughout the year 2013 to 2017 originates from the north (0°) and northeast (45°) of the plant as shown in Fig. 3 above. Thus, the south and southwest section, which is located downwind of the prevailing wind of the plant will be severely affected in the event of a chlorine release. However, by referring to the consequences modelling results for similar scenarios, the chlorine release distance for different wind speeds at different concentrations could extend beyond the water treatment plant boundary. The impact on the surrounding population as shown in Table 3.

**Table 3 Residential Population Distribution Along the Downwind Path**

Distance (m)	Direction	Label	Estimated population	
			Day	Night
<10	Source	1 - WTP	125	11
500	South	2 - EQP	150	50
1000	South west	3- MIB	60	120
1200	South	4 -IWK	35	6
1300	South west	5- CC	8700	650
1400	South West	6- RQ1*	373	2115
1500	South west	7 -SR	1732	2

1600	South west	8- SM	714	2
1700	South West	9- CON	100	20
1900	South West	10- RQ2*	548	3408

(source = From telephone conversation from respective personnel except for \*)

Key: WTP = Water Treatment Plant, EQP= Equestrian Park, MIB= Medan Ikan Bakar, CC = Convention Center, IWK = Indah Water Konsortium, RQ1= Residential Quarters 1, SR = Sekolah Rendah, SM = Sekolah Menengah, CON = Construction Area and RQ2 = Residential Quarters 2

\*based on estimation from Bahagian Pengurusan Hartanah (JPM)

It should be highlighted as that the tabulated results are referring to the worst-case scenario in consequence modelling. It should be noted that the tabulated results are referring to the worst-case scenario in consequence modelling. Table 4 illustrates the affected areas, the corresponding people that exposed to the 2m/s wind speeds for both the north and northeast direction and high concentration risk exposure.

**Table 4 Areas and Population Affected at Different Wind Speeds for Worst-Case Release**

Event	Effect Level & distance	Downwind Distance	Wind direction	Affected Area	Affected Population	
					Day	Night
Chlorine Toxic Cloud Release from drum catastrophic Rupture	500ppm	170.1m	From North (0°)	WTP	125	11
	100ppm	672.2m		WTP & EQP	275	66
	50 ppm	1132.0m		WTP, EQP	275	66
	10 ppm	3220.0		WTP, EQP & IWK	310	72
	500ppm	170.1m	From North east (45°)	WTP	25	11
	100ppm	672.2m		WTP & EQP	275	66
	50 ppm	1132.0m		WTP, EQP & MIB	335	186
	10 ppm	3220.0		WTP, EQP, MIB, SM, SR, 50% CC, 50%CON, 50%RQ1 & 50%RQ2	7677	3288

## 4.0 DISCUSSION

### 4.1 Toxic Gas Dispersion

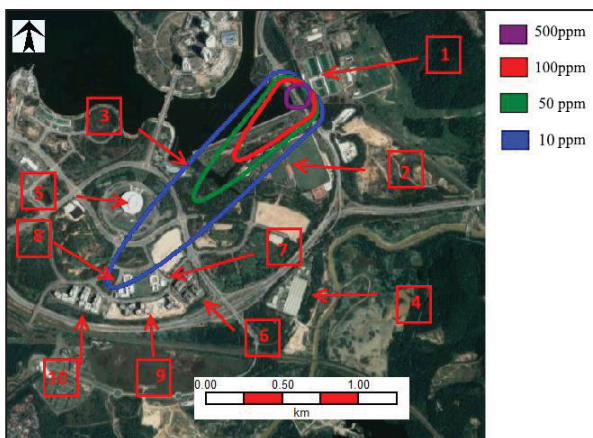
Based on the results in Table 2, it is estimated that 930 kg of saturated liquid chlorine was released into the atmosphere at a flow rate of 0.6 kg / s within 26.9 minutes for the release of the liquid phase scenario, while chlorine gas takes a long time to escape under the vapor phase scenario, the discharge rate is at 0.06 kg / s. PHAST software estimates the escape of 198.7 kg of chlorine vapors is within an hour. As for the initial release stage, the drum is full and the internal pressure is 8 bar, but as the chlorine level drops, the internal pressure will then approach the ambient pressure causing the flow to stop from the upper side hole of the drum. As for the vapor phase scenario, emptying the entire drum volume takes about 9.8 hours long. The release of chlorine into the atmosphere over a long period of time is also the same as the continued release that can lead to plume (Iyuke et al, 2004). For liquid phase release, the discharge rate takes less than 30 minutes to empty the entire chlorine drum and, in the process, some portion of the chlorine released will either become aerosol or fall to the ground as liquid, while 930 kg of chlorine in a drum was assume to be released within a time frame of fewer than 5 minutes in a catastrophic release case. No mitigation function was activated at the time of the release. All liquid chlorine was spilled on the ground. The situation is similar to sudden or instantaneous release in a catastrophic and liquid release scenario where the condition can lead to puff (Paul & Mondal, 2014).

The dispersion of a pollutant gas depends on wind velocity (Safakar et al., 2016) (Paul & Mondal, 2014). In the presence of turbulent wind speeds which is class B stability, the plume being buoyant will disperse more in the vertical direction compared to the downwind direction. As the concentration of the chlorine is constant over the duration of the continuous release, the dilution will be more intense and aggressive at a higher wind speed (Iyuke et al., 2004). Dense chlorine gas is released in the ventilated area of the building containing the chlorine drum, promoting the mixing with the air and moisture in the air squarely to the B atmospheric stability level during its descent to a lower level. This indicates that complete dilution of chlorine occurs immediately upon release from the building and maintained at the height prior to a complete dispersion. For stability F, the wind is more stable (Crowl & Louvar, 2002) therefore the dilution of chlorine would be less accord. It will be impossible for the developed vapor to quickly mix in the atmosphere after the released as it will be continuously transported by the wind. Moreover, in comparing the class F stability to class B stability, class F stability has an enormous toxic cloud coverage over distance. According to Soman, A. R (2015), Naimeh Setareshenas (2014) the atmosphere stability makes a lot of different in the dispersion of the toxic downwind. The class F stability gave the longest distance to toxic gas dispersion in all leak scenarios.

The worst-consequences scenario of chlorine leakage with a chlorine concentration of 10 ppm for a total rupture scenario, the studies has shown that the chlorine cloud reaches up to 3.2 kilometers from the source under class F atmospheric conditions. The area coverage is up to 1.06 km<sup>2</sup>.

#### 4.2 Effect on People On-Site and Off-Site

Referring to Fig. 5 below, for 45° of wind direction and 10 ppm concentration of chlorine the downwind distance is 3.2 km, the toxic cloud did not reach the CC (label 5), RQ1 (label 6), CON (label 9) and RQ2 (label 8) but the plume cloud slightly encroached into this area. Presuming half of this area and its population was exposed to SR (label 7), and part of the school area was covered by the toxic cloud of 10 ppm, the overall population surrounded the school area is affirmed to be affected. It has been extrapolated the total number of 7677 people were affected at 10 ppm of concentration in the daytime and 3288 people were affected at night time.



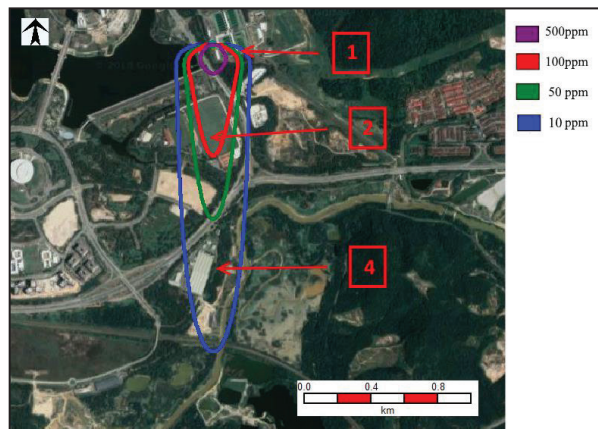
**Figure 5 Affected Area From 45° Wind Direction for Worst Scenario**

For a 50 ppm chlorine concentration, 335 people were affected at the day time and 186 people were affected at night time. At this distance, it should be alarming as that the toxic cloud has reached the public area and the public are exposed to the toxin. Relatively as for 100 ppm chlorine concentration, 275 people are affected at the daytime and 66 people are affected at night time. Within the plotted area, the affected population is mostly workers or visitors at EQ (label 2) and personnel at the WTP (label 1). For 500 ppm level of concentration in wind direction of 45°, affected area are at the WTP plant and the surrounding area at a distance of 170m. The highest concentration of the toxic cloud covered the main road in front of the WTP. 125 people of the population are affected at daytime and 11 personnel that work at night time.

Fig. 6 below shows the affected area for the wind direction from 0° (north). For the 10ppm chlorine concentration at a downwind distance of 3.2km, 310 people are affected at daytime and 72 people at night time. The population mainly resides at WTP (label 1), EQ (Label 2) and IWK (label 9). For 50 ppm chlorine concentration, 275 people are affected in the daytime and 66 people at night time. The total number of the population affected is the same as for 100 ppm concentration because there are found no buildings neither population exists. Yet, there is the main road across the path of the toxic cloud in the downwind direction. As for 1000 ppm concentration, 125 people are affected at the daytime and 11 personnel who work at the night time. This quantity is the same as the affected population in the 0° wind direction. Based on this study, it can be concluded that most of the population exposed to toxic clouds is caused by the northeast wind blowing from the source compared to the north direction. There are a number of new and ongoing developments in the southwest of the WTP. It is necessary to focus on the results obtained from the consequence analysis to reduce the potential risk and danger in the water the treatment plant, which stored more than 60 MT of chlorine to disinfect water and support on municipal water supplies to the community.

## 5.0 CONCLUSION

The conclusion can be drawn from this research study by applying the Consequence Modelling to Potential Major Hazard Accident of Chlorine Gas Leakage in the Water Treatment Plant. The loss of containment of chlorine at the Water Treatment Plant has been investigated and simulate using consequence analysis package software PHAST 8.11. The release of toxic gases into the surrounding environment could cause a hazard and severe damages.



**Figure 6 Affected Area From 0° Wind Direction for Worst Scenario**

Based on the study it has been identified that the worst-case scenario is the catastrophic event of chlorine drum rupture, which can cause instantaneous release 930kg of liquid chlorine at the chlorine storage room. In general, the concentration of chlorine in the downwind path deem to cause fatality. However, anyone who has not been exposed to an attention level that could affect their health should proceed to escape in a safe area. The assembly point of the water treatment plant should be located in a safe area. It is assumed that people can survive and escape when exposed to toxic concentrations below 1000 ppm and yet fatality is assumed to be exposed to a higher concentration value.

Based on the PHAST modelling, it is proven with the evidence that higher emission rates cause the expansion of toxic cloud coverage. This can be observed by comparing the size and location of the ruptures with a similar chlorine mass of 930 kg, an operating pressure of 8 bar, and a wind speed of 2m/s. By referring to the findings, the catastrophic fracture at the atmospheric, stability F shows the longest downwind distance when the IDHL value is at 10 ppm, the distance of 3.2 km, which may affect 7677 people corresponding to the wind direction of the northeast (45°).

As a conclusion, it would be an ideal approach to perform consequence modelling using PHAST software as a method to indicate potential Major Hazard Accident of chlorine gas and evaluate the distribution of chlorine gas at off-site to detect over various leak scenarios. A gas detection system is an important safety system which can interface with several other safety systems and it is able to address leaks before they become a disaster.

### ACKNOWLEDGEMENTS

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## OSHCIM Implementation Readiness from the Perspective of Designers and Contractors in Malaysia Construction Industry

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**ABSTRACT:** DOSH Malaysia has developed Guidelines on Occupational Safety and Health in Construction Industry (Management) 2017 (OSHCIM) based on "Prevention through Design" concept, where clients, designers, contractors, competent persons, and other stakeholders shall work together. This study aims to determine the readiness of designers and contractors on OSHCIM implementation. Questionnaires and interviews were adopted to collect individual's perception and to measure on both the designers and contractors' adherence to OSHCIM practices. The results shown that there is a statistically significant difference between the designers and contractors' views on "Prevention through Design". In general, the designers exhibited a lower mean score compared to the contractors, especially in areas related to safety, cost, damages, and flawed design. This evinced that designers seem reluctant to synthesize the OSHCIM concept in their designs. Likewise, the contractor scored 3.45 out of 4, manifested the receptiveness of OSHCIM implementation could improve the coordination between the client and other parties. In contrast, the designers could barely obtained a lower of 3.03. Designers seem to be less convinced compared to the contractor on OSHCIM implementation which could improve the coordination between client, designer, and contractor.

**Keywords:** Contractors, Construction Industry, Designers, OSHCIM, Prevention through Design, Survey

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### 1.0 INTRODUCTION

The construction industry is considered as one of the most dangerous occupations alarming a high casualty rates in many countries, including Malaysia. The construction industry accounts for 8 per cent of the total workforce in the United States has led to 20% of fatalities. Roughly, it is estimated that there are about 1,100 deaths annually and 170,000 serious injuries annually (CPWR, 2007). Fall is the top leading cause of fatality in construction. The most common situation leads to falls include the process of making connections, walking on beams, and walking close to openings such as floors or windows. Fall protection is required at height of 6 feet above a surface (Lingard, Harley, Pirzadeh, & Wakefield, 2014). The risk factors for falls are slippery surfaces, unexpected vibrations, misalignment, and unexpected loads.

Behm, (2005) reported in Oregon, Washington, and California, claiming on 22% of the 226 injuries occurred from 2000 to 2002 were partly due to construction design. Pretty close to the reported rate in the U.S., 42% of 224 fatalities happened in the construction site between 1990 and 2003 were relate to construction designs. European Foundation reported that 60% of fatal accidents resulted in part from decisions made before site work began. NSW WorkCover (2001) reported that 63% of all fatalities and injuries could be attributed to design decisions or lack of planning (NOHSC, 2001).

According to Driscoll et al (2008), design contributes significantly to work-related serious injury where 37% of workplace fatalities are due to design-related issues (Hale, Walker, Walters, & Bolt, 2012). This proves that design is a risk factor that contributes to fatalities in the construction site. Therefore, the introduction of the concept of prevention through design (PtD) can be beneficial to the construction industry (Torghabeh & Hosseinian, 2012). The terminology used for prevention through design in the US is known as “safe design” in Australia and “design for safety” in the UK. While in Malaysia, it is versed as Occupational Safety and Health in Construction Industry (Management) or OSHCIM. The UK, Australia and Singapore have mandated the practices of PtD through the regulations, however in Malaysia, the Ptd practices or OSHCIM 2017 is yet to be enacted as regulation.

Prevention through Design (PtD) was developed as a proactive method in design processes furthermore to eliminate or to reduce work-related hazards or illness thence to minimize risks associated with construction, manufacturing, maintenance, use, reuse, and disposal of facilities, materials, and equipment (Lingard et al., 2014). PtD in construction is explicitly considering construction and maintenance safety in the design of a project. The PtD concerns about workers' safety and values safe construction and maintenance especially to workers performing tasks at the construction sites.

Design has major leverage where ability to influence key project goals is greatest early in the project schedule during planning and design stage (López, Carlos, Romero, & Gibb, 2012). In situations when safety issues are not discussed during the design phase, building occupants might expose to the risk of injury and when designs are ‘unconstructive’, it is more dangerous to build as well as to maintain. Therefore, safe design should be integrated with the construction processes at the earliest stages of the project's life cycle. There are countless advantages if safe design is integrated in construction for instance cost-saving, shorter schedule, improves quality, sustainability and certainly create a greater control over safety. The core component of the PtD is similar to the hierarchy of control system which aimed to minimize occupational hazards at the early stages of the design process. PtD concept emphasizes on addressing hazards at the top of the hierarchy of controls (mainly through elimination and substitution) at the early stages of project development (Lu, Li, Zhou, & Deng, 2015). PtD addresses public safety and ethical issues and mainly to forecast safety risks in construction activities or any other design-related matters. The advantages of PtD concept includes reducing site hazards with fewer injuries, aid on workers' compensation and insurance, increases productivity with fewer delays, strengthens designer-contractors' cooperation, reduce absenteeism, improves morale as well as to reduced employee turnover (Gambatese, Behm, & Rajendran, 2008).

The success of a construction project is highly dependent on design inputs provided by the stakeholders such as users, owner, facility management personnel and contractors. Constructability review and feedback should be consolidated and start from the design phase. In short, PtD is an emerging trend in construction safety whereby the application could save life, reduce duration and cost, last but not least protecting the workers. It is the designer's ethical duty to create drawings with good constructability. The objective of this paper is to identify the OSHCIM implementation readiness from perspective of designers and constructors through survey. Although Malaysia has yet to enact OSHCIM 2017 Guideline as a regulation, it is necessary for us to rectify issues promptly ensuring OSHCIM can be implemented in the construction industry.

## **2.0 METHOD**

### **2.1 Research Objective**

The aim of the study is to discover the readiness and tendency from both designers and contractors to implement OSHCIM for the construction industry. The variables of interest were measured using a questionnaire survey and interviews with participants from JKR, inclusive government and special projects in Johor, Penang, Selangor, Terengganu, Sabah, Sarawak, Putrajaya, and Kuala Lumpur. Besides, the research study also provides an analysis of the current industry practices among designers and contractors and recommends OSHCIM implementation enforced by the Department of Occupational Safety and Health.



## 2.2 Instrument

The study was conducted in Malaysia involving contractors and designers. The research study includes 600 respondents whereby both the designers and the contractors received 300 surveys each. However, 100 surveys are returned by the designers and 106 surveys returned by the contractors for further analysis.

This research mainly adopted both the research tools, the questionnaire-based survey and interviews. There are five sections in the questionnaire. Section A refers to the respondent's demographic profile and background while Section B refers to the respondent's general statements related to safety and health knowledge. A 4-point Likert scale used 1- Strongly Disagree, 2- Disagree, 3- Agree and 4- Strongly Agree is applied for both Section A and B. Section C refers to Designers and Contractors' Roles and responsibilities on OSHCIM requirements, Section D refers to Management Practices and Section E refers to Training Practices. For Section D and E, the Likert scale measures the frequency of current practices, 1- Never, 2- Seldom, 3- Often and 4- Always practice. During the interview session, selected contractors and designers required to reveal an individual's data from the perspective of safety and health opinions, knowledge, skills and experience related to the implementation of OSHCIM.

The purpose of this interview is to reach a consensus on issues arises as well as implementation efforts for OSHCIM. The survey data collected were analyzed using the Statistical Package for the Social Science (SPSS) software where means and t-test analyses were obtained.

## 3.0 RESULTS AND DISCUSSION

In total, 100 designers and 106 entrepreneurs from 15 companies returned the surveys for further analysis. The designers and contractors' demographic profile are shown in Table 1. Approximately 30% of designers and 33% of contractors have less than five years of construction experience. However, most designers (34%) and contractors (39%) from these organizations are having more than 25 years of experience in the construction industry. In terms of the work location, majority of the designers work in Sarawak and most of the contractors work in Johor. The highest percentage of the designers are working as an architect (56.7%) and as engineers (18.6%) and none of them working as safety and health officers. Whilst for contractors, 39% of them are working as engineers, 28% are working as project managers and 24.8% are safety and health officers. Most of the designers (56%) and contractors (41%) has a bachelor's degree as their highest academic qualification.

**Table 1 Demographic Profile of Respondents**

Variable		Designer		Contractor	
		Total (n=99) (%)		Total (n=106) (%)	
Personal Experience	<5 years	30	(30.30)	35	(33.02)
	5-10 years	27	(27.27)	31	(29.25)
	10-15 years	14	(14.14)	18	(16.98)
	15-20 years	6	(6.06)	8	(7.55)
	20-25 years	9	(9.09)	6	(5.66)
	>25 years	13	(13.13)	8	(7.55)
Variable		Designer		Contractor	
		Total (n=100) (%)		Total (n=103) (%)	
Organization Involvement	<5 years	15	(15.00)	16	(15.53)
	5-10 years	12	(12.00)	19	(18.45)
	10-15 years	14	(14.00)	10	(9.71)
	15-20 years	11	(11.00)	6	(5.83)
	20-25 years	14	(14.00)	13	(12.62)

		>25 years	34 (34.00)	39 (37.86)
Variable	Designer		Contractor	
	Total (n=90) (%)		Total (n=100) (%)	
Location	Johor	15 (16.67)	53 (53.00)	
	Melaka	0 (0)	1 (1.00)	
	Pulau Pinang	11 (12.22)	14 (14.00)	
	Sabah	3 (3.33)	5 (5.00)	
	Sarawak	49 (54.44)	14 (14.00)	
	Selangor	4 (4.44)	5 (5.00)	
	Terengganu	3 (3.33)	5 (5.00)	
	W. P. Kuala Lumpur	5 (5.56)	3 (3.00)	
Variable	Designer		Contractor	
	Total (n=97) (%)		Total (n=105) (%)	
Designation	SHO	0 (0)	26 (24.76)	
	Engineer	18 (18.56)	41 (39.05)	
	Project Manager	2 (2.06)	30 (28.57)	
	Architect	55 (56.70)	0 (0.00)	
	Director	6 (6.19)	0 (0.00)	
	Other	16 (16.49)	8 (7.62)	
	Variable	Designer		Contractor
Total (n=99) (%)		Total (n=105) (%)		
Highest Academic Qualification	Diploma	7 (7.07)	37 (35.24)	
	Bachelor's Degree	56 (56.57)	43 (40.95)	
	Master	17 (17.17)	6 (5.71)	
	PhD	3 (3.03)	2 (1.90)	
	Professional Competency	14 (14.14)	12 (11.43)	
	Other	2 (2.02)	5 (4.76)	
Variable	Designer		Contractor	
	Total (n=89) (%)		Total (n=105) (%)	
Social Amenities (Public)	None	25 (28.09)	61 (58.10)	
	1-25	53 (59.55)	38 (36.19)	
	26-50	8 (8.99)	3 (2.86)	
	>50	3 (3.37)	3 (2.86)	
Variable	Designer		Contractor	
	Total (n=79) (%)		Total (n=105) (%)	
Social Amenities (Private)	None	30 (37.97)	69 (65.71)	
	1-25	43 (54.43)	29 (27.62)	
	26-50	6 (7.59)	6 (5.71)	
	>50	0 (0.00)	1 (0.95)	
Variable	Designer		Contractor	
	Total (n=81) (%)		Total (n=105) (%)	
Infrastructure (Public)	None	35 (43.21)	51 (48.57)	
	1-25	35 (43.21)	40 (38.10)	

	26-50	4 (4.94)	10 (9.52)
	>50	7 (8.64)	4 (3.81)
		Designer	Contractor
	Variable	Total (n=77) (%)	Total (n=105) (%)
Infrastructure (Private)	None	44 (57.14)	67 (63.81)
	1-25	26 (33.77)	27 (25.71)
	26-50	2 (2.60)	10 (9.52)
	>50	5 (6.49)	1 (0.95)
		Designer	Contractor
	Variable	Total (n=73) (%)	Total (n=105) (%)
Residential (Public)	None	28 (38.36)	61 (58.10)
	1-25	32 (43.84)	32 (30.48)
	26-50	4 (5.48)	8 (7.62)
	>50	9 (12.33)	4 (3.81)
		Designer	Contractor
	Variable	Total (n=91) (%)	Total (n=105) (%)
Residential (Private)	None	11 (12.09)	34 (32.28)
	1-25	54 (59.34)	54 (51.43)
	26-50	7 (7.69)	11 (10.48)
	>50	19 (20.88)	6 (5.71)
		Designer	Contractor
	Variable	Total (n=73) (%)	Total (n=105) (%)
Non-residential (Public)	None	25 (34.25)	62 (59.05)
	1-25	37 (50.68)	34 (32.28)
	26-50	3 (4.11)	5 (4.76)
	>50	8 (10.96)	4 (3.81)
		Designer	Contractor
	Variable	Total (n=89) (%)	Total (n=105) (%)
Non-residential (Private)	None	13 (14.61)	43 (40.95)
	1-25	56 (62.92)	48 (45.71)
	26-50	8 (8.99)	10 (9.52)
	>50	12 (13.48)	4 (3.81)

### 3.1 General Statements Related to Respondents' Safety and Health Knowledge

Table 2 shows the mean result according to the Likert scale as mentioned, 1 indicate as (Strongly disagree) and 4 indicate as (Strongly agree) to measure on designers and contractors' knowledge of safety and health. There were 8 out of 11 questions that showed a statistically significant difference with a p-value less than 0.05 between designers and contractors. This mean result exhibit on contractor's tendency to agree upon the distributed questionnaires compared to designers. Based on the survey result, we can vouch on that contractors are fully aware that safety and health is a critical criterion in construction. Referring to question number 7, the contractors achieved a mean score of (3.48) much higher than designers (3.05). There is a statistical difference between the two. Significantly, contractors stance with a positive assurance and firmly believes the OSHIM implementation could bring advantages for the project compared to the designers.

As for question one, three and five, both the designer and contractors achieved a mean score without reflecting any significant difference ( $p < 0.05$ ). By all means, both the designer and contractor assured that zero accident is achievable. Proper planning on safety and health should start early in order to avoid non-compliance to safety and health regulation. Violators will be subject to legal action.

### 3.2 Management practices of respondents toward OSHCIM 2017 Guideline

Contractors acceded that they are responsible for protecting employees' safety and health, the mean score achieved (3.3905) compared with the mean score attained from the designers (2.8586) steering significant difference of ( $p < 0.05$ ). In confronting the inference, it is clear that the designers had a variance of opinions from the contractors to hold accountable for workers' safety and health. However, the safety and health of workers should be one of the factors that the designers should take into consideration. Designers should understand that design could influence or even cause an impact on workers' safety. Thus, the designer should realize the accountability held during the design phase and gain a better understanding of the importance of workers' safety and health.

### 3.3 Training Practices of Respondents toward OSHCIM 2017 Guideline

Contractor and designer shown a significant differences in mean scoring ( $p < 0.05$ ) for question number two and three. As reported, (3.217) contractors had attended construction safety training while (2.8774) attended a specific course of updating client's record on safety and health. Similarly for designers scores at (2.83 and 2.1224) respectively. Based on the result, it explicates that the designers were inadequately trained on safety and health discipline to compare to contractors. Therefore, designers should elevate trainings or join specific courses related to safety and health in construction. As for question number one, there are no statistically significant differences in the mean score of ( $p < 0.05$ ) among the designers (3.2) and contractor (3.16). This result indicated that both have adequate knowledge of legal requirements, theories, technical and practical discipline of construction projects.

This study revealed on the readiness and adherence to OSHCIM implementation differ between designers and contractors. In the implementation of OSHCIM, designers and architects are less preferred than contractors. Contractors believes that the OSHCIM implementation can benefit the construction project by outweigh the project costs. The researcher may conclude that the contractor has gained a deeper understanding from the architect in construction processes and operation, worker safety, handling constructability issues and in identifying hazards and safety risks at construction sites. The study also found that designers had limited knowledge of construction safety compared to the contractors. DOSH should therefore be attentive to raise awareness of the implementation of OSHCIM through seminars or professional short courses to designers.

**Table 2 OSCHIM Readiness between Designers and Contractors**

Questions	Mean		T-test	p-value
	Designer	Contractor		
General Statements				
I agree that: (1 = Strongly Disagree and 4 = Strongly Agree)				
1. ..zero accident is achievable.	3.16	3.2642	1.046	0.297
2. ..accident/incident would damage my company reputation...	3.53	3.7358	2.646	0.009
3. ..proper planning on safety and health should start early...	3.55	3.6509	1.372	0.172
4. my company become a preferred designer/contractor...	3.14	3.4811	3.715	0
5. non-compliance to safety and health regulation will be subjected to legal action...	3.43	3.4528	0.274	0.784
6. a bigger penalty will encourage to design-out the hazard...	2.8	3.3774	6.072	0
7. safety and health is a critical criterion...	3.05	3.4762	4.83	0

8. I aware that OSHCIM requirement will improve the coordination...	3.03	3.4528	5.729	0
9. OSHCIM will not increase the operational cost...	2.43	2.8491	3.854	0
10. the implementation of OSHCIM can be applied by using the existing manpower.	2.68	3.0571	4.113	0
11. OSHCIM should be implemented in all size of construction projects.	3	3.3238	3.5	0.001
<b>Management Practices</b>				
(1 = Never and 4 =Always)				
1. I design code of conduct, ethics and policy to address the requirement on safety and health.	2.899	3.1143	1.546	0.124
2. I know that I am responsible towards workers safety and health...	2.8586	3.3905	4.544	0
<b>Training Practices</b>				
(1 = Never and 4 =Always)				
1. I have adequate knowledge on legal requirements...	3.2	3.1604	0.383	0.702
2. I attend a formal construction safety and training...	2.83	3.217	3.258	0.001
3. I attend specific course to enable me to update SHF for Client...	2.1224	2.8774	5.839	0

#### 4.0 CONCLUSIONS AND RECOMMENDATION

This study revealed that readiness and adherence to OSHCIM implementation differ between designers and contractors. In the implementation of OSHCIM, designers and architects are less preferred than contractors. Contractors believes that the OSHCIM implementation can benefit the construction project by outweigh the project costs. The researcher may conclude that the contractor has gained a deeper understanding from the architect in the discipline of construction processes and operation, worker safety, handling constructability issues and in identifying hazards and safety risks at construction sites. The study also found that designers had limited knowledge of construction safety compared to contractors. DOSH should therefore be attentive to raise awareness of the implementation of OSHCIM through seminars or professional short courses to designers.

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# The Risks of Work-Related Musculoskeletal Disorders among Business Service Center Workers

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**ABSTRACT:** *Work-related musculoskeletal disorders (WMSD) has become one of the occupational health issues in this industrial world including Malaysia. Epidemiological studies have shown that musculoskeletal disorders are widely prevalent among employees who work with computers. The purpose of this study was to identify whether the duration of visual displaying unit (VDU) usage could contribute to the risk-level of work-related musculoskeletal discomforts (WMSD) in various body regions. A cross-sectional study comprised 300 workers was conducted among employees in a business service centre who are using VDU for their daily routine tasks. The results showed a high prevalence rate of WMSD and there was also statistically significant difference between the hours of VDU usage and the risk-level of WMSD towards their body regions. This study also concluded that the risk-level of WMSD increases according to the length of VDU usage duration.*

**Keywords:** *Ergonomic, Occupational Health, Occupational Safety & Health, VDU, Work-related Musculoskeletal Disorder,*

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## 1.0 INTRODUCTION

Work-related musculoskeletal disorders (WMSD) represents the most common occupational health disease in this industrial world (Hossain et al., 2018; Franco, 2010). WMSD has also been found as the main occupational health issue in Japan as well as Korea (Kim & Nakata, 2014). Similarly, WMSD is also becoming one of the main occupational health problems in Malaysia as it is reported to be the second highest occupational diseases in the country (SOCSCO, 2009-2016). Furthermore, 153 out of 603 recorded occupational diseases are categorized as ergonomics related cases and were financially compensated by SOCSCO in 2014 (SOCSCO, 2015). Moreover, WMSD cases increase in a double figure from 2008 to 2009 as per reported in SOCSCO Annual Report (SOCSCO, 2010). These statistics proves that ergonomic hazards in workplaces must be seriously addressed and prompt actions should be taken by relevant parties in preventing WMSD from continually increasing in Malaysia.

WMSD among workers brings serious impact to an organization. Gallagher and Heberger (2012) revealed that WMSD is a major cause of lost workdays (average four days) in industries. Moreover, WMSD also is accounted for the highest rate of disability among workers as well as economic cost associated with considerable amount of disability, sick leave, compensation days, and loss of productivity (Yassi, 2000; Straaton, 1998; Cole 1996). Ergonomic factors are found to be the main factor towards WMSD. Ergonomics factors are such as work station design, repetitive movement, awkward position, prolong standing and sitting, manual handling as well as vibrations. A work by Buckle (2005) concluded that work station design, lighting, and video display unit (VDU) are factors which could contribute to WMSD. Meanwhile, other researchers stated that factors which could lead to WMSD are 'work factors' namely workload, job demands, hours worked with computer, consistent awkward postures, psychological and psychosocial stress (Bernard et al. 1994; Bongers

et al. 1993; Carayon & Smith 2000). Computers or also renowned as visual displaying unit (VDU) is one of the factors which could contribute to WMSD among involved workers. This fact has been determined by several researchers such as Ardahan & Simsek (2016) who found that one of the factors towards WMSD is the ever-increasing usage of computers. In addition, Wu et al., (2012) has also determined that musculoskeletal disorders (MSD) usually occurs on the neck, shoulders, and upper limbs of the body when a worker uses computer for a long duration of time.

Ardahan and Simsek (2016) performed a study on 395 office workers and analyzed the prevalence of WMSD among computer-users. Base on the results acquired, 67.85% of participants reported musculoskeletal discomforts symptoms in the neck, 66.33% in back, 59.49% in lower back, and 45.32% at right shoulder. The research also distinguished that musculoskeletal discomfort risks was relatively high among the long daily computer-users. On the other hands, Noroozi et al. (2015) stated that office works are among the jobs that have high prevalence of musculoskeletal disorders. Prolonged sitting and working with computer are some of the causes for workers to experience musculoskeletal disorders. Moreover, Kaliniene et al. (2016) conducted a study among office workers using RULA checklist. The study indicated that the prevalence rates of shoulder, elbow, wrist hand, upper and low back pain were 50.5 %, 20.3 %, 26.3 %, 44.8 %, and 56.1 %, respectively. Computer work experience factor was found as significant towards musculoskeletal pain in various body regions, besides individual factors namely gender, age and body mass index.

The duration of VDU usage has also been found as a contributor towards WMSD. According to Mozafari et al. (2013), there was a relationship between work length with VDU as well as prolonged sitting position with the prevalence of WMSD. Gerr and Monteilh (2004), in their research, has reported an association between health outcomes and daily hours of computer use. The study revealed a significant impact imposed by the duration of VDU usage on eye discomfort as well as WMSD. These results were similar to Al-Wehedy et al., (1999) and Jensen (2004) who also determined that the duration of VDU usage among employees predict a high prevalence of musculoskeletal disorders as well as headache.

In BP Business Services Centre (BPBSC), employees spend most of their time at VDU terminal performing their daily routine tasks. With such working nature, they are highly exposed to ergonomic related hazards. Majority of workers in BPBSC are female. They work in sitting position for an average of 8 hours per day, using personal computer. A preliminary survey had been conducted among the clerical staff in 2015. Based on the interview, more than 300 employees admitted that they experience muscle pain and discomfort due to work.

Therefore, this study aims to determine the risk of WMSD among BPBSC staff based on the hours of working with VDU. In specific, the objectives of the study are as follows:

1. To determine the prevalence rate of WMSD among BPBSC staff
2. To distinguish WMSD risk level according to the duration length of VDU usage among the clerical staff in BPBSC.
3. To examine the effect of VDU usage duration towards WMSD risk level based on body reigns among the clerical staff in BPBSC.

In terms of the significant of study, this research is expected to contribute to the employer as the findings could become referral data in order to plan and implement further adjustment and improvement, especially in terms of workstation design in order to prevent WMSD. This study's results would become the only empirical evidence towards the employer regarding to the prevalence of WMSD among its clerical staff and should lead to further planning of preventive interventions. Besides, this study could serve as an additional reference for the relevant government agencies to establish related program on instilling knowledge about WMSD prevention among office workers. The results also could become part of reference in developing standard guidelines or industrial code of practice- ICOP related to ergonomic at workplaces.

Lastly, this study is expected to contribute to the body of knowledge in terms of the prevalence rate of WMSD among office workers, plus the impact of VDU towards WMSD risk. The findings could contribute in updating the literature on this area.



## 2.0 METHOD

This research is a quantitative design research and the data is collected using a self-administered questionnaire. The subject of this study comprised the visual display terminal users in BPBSC, Kuala Lumpur. A questionnaire consists two sections has been used as the research instrument. The first part of the questionnaire was designed to gather the personal demographic details of the respondents'age, gender, and daily computer using duration. The duration of computer usage daily was categorized into three which are 2-4 hours, 5-7 hours and 8 hours & above, adapted from Wu et al., (2012) with some modification to suite the working hours of BPBSC, Kuala Lumpur. Meanwhile, the second part of the questionnaire was designed to assess the musculoskeletal pain involving 12 body region: neck, shoulders, elbows, wrists/hands, forearm, mid back, lower back, hips, thighs, knee, lower legs, and foot. For the purpose of assessing the prevalence of WMSD according to body regions, the Nordic Musculoskeletal Questionnaire was adopted based on (Kuorinka et al., (1987). Furthermore, to determine the WMSD risk, a formula which Risk = Likelihood x Severity (Ayyub, 2003) was applied. Table 1 depicted the severity scale whilst Table 2 depicted the likelihood scale applied for this research.

**Table 1 Severity**

Scale	Severity
1	Comfortable all the time
2	Always comfortable
3	Slightly Discomfort
4	Medium discomfort
5	Very discomfort

**Table 2 Likelihood**

Scale	Frequency/Likelihood
1	Rarely
2	Frequently
3	Constantly

Subsequently, the risk matrix used for this research in order to distinguish risk level of WMSD was developed. The development of the risk matrix was based on the adaptation and modification from the Guidelines of Hazard Identification, Risk Assessment and Risk Control – HIRARC (DOSH, 2009). Post to the modification, the risk matrix was sent to experts of OSH for comments and suggestion of improvement. The experts selected are DOSH officers, occupational health doctors and academicians from renowned public universities. After minor modification, the finalised risk matrix for WMSD was produced as depicted in Table 3.

**Table 3 Risk Matrix (DOSH, 2009)**

Risk Rating	Risk Level	Action
0-3	Low Risk	Acceptable; further reduction may not necessary
4-8	Medium Risk	Requires a planned approach to control the hazard and applies temporary measure if required.
9-15	High Risk	Requires immediate action to control the hazard as detailed in the hierarchy of control.

The target population for this study was the staffs that work with computer in BP Business services Centre office, Bangsar, Kuala Lumpur. The study chose 300 office workers using simple random sampling procedure, which gives everyone an equal chance of being selected. The sampling number was determined based on sampling table introduced by Krejcie and Morgan (1970). The data has been analysed quantitatively using the Statistical Package for the Social Sciences (SPSS) version 20. Descriptive and inferential analyses have been chosen as the data analysis methods. Descriptive percentage will be used to determine the prevalence rate of MSD. Whilst, ANOVA analysis techniques was used to analyse the significant difference the hours of daily VDU usage and the risk-level of WMSD.

### 3.0 RESULTS AND DISCUSSION

This section reports the results of this research results obtained from the statistical data analyses. Furthermore, this section also would discuss the findings of the results.

#### 3.1 Descriptive Analysis

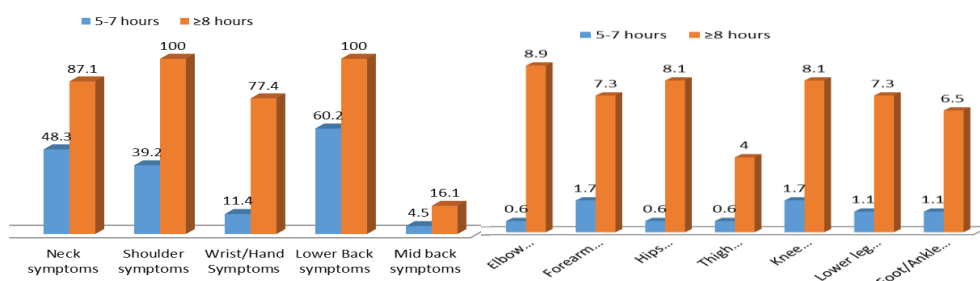
Table 4 depicted the results of descriptive analysis.

**Table 4 Descriptive Analysis**

Demographic Data		WMSD	
		Yes	No
Gender	Female	153 (51%)	29(9.7%)
	Male	103 (34.3%)	15 (5%)
Age	22-35y	141 (47%)	27 (9%)
	36-45y	76 (25.3%)	12 (4%)
	46-55y	32 (10.7%)	5 (1.7%)
	≥56	7 (2.3%)	0 (0%)
Duration Computer usage Daily	5-7 hours	139 (46.3%)	37 (12.3%)
	≥8 hours	117 (39%)	7 (2.3%)

Based on the results in Table 4, the prevalence rate of WMSD is 85.3%. There was a sum of 153 (51%) of female workers experience a musculoskeletal symptom and the remaining 34.3% were male. Majority (47%) of the respondents who had musculoskeletal symptoms was within age 22-35 years old, 25.3% within age 36-45 years old, 10.7% within the age 46-55 years old and only 2.3% at the age more than 56 years old. None of the respondent are working with a computer below than 5 hours daily. There was 46.3% of the respondent who have reported to have musculoskeletal symptoms, work with VDU for 5-7 hours daily and 39% work with a computer more than 8 hours daily.

Subsequently, the results revealed that the entire respondents are working with VDU for more than 5 hours daily. A total of 46.3% of the respondents who are working with computer for 5-7 hours daily reported to experience high risk in lower back symptoms (60.2%) followed by neck (48.3%), shoulder 39.2%) and wrist/hand (11.4%). Respondents who are working with a computer more than 8 hours reported having high risk in lower back (100%), shoulder (100%), neck (87.1%), and wrist/hand (77.4%). On the other hands, respondents who work more than 8 hours have also reported to experience mid back symptoms (16.1%). The risk of getting musculoskeletal symptoms in all body regions is higher when there is an increasing in the duration of daily computer usage. Based on the descriptive analysis, the results show that the prevalence of WMSD among clerical workers in BPBSC is high which is 85%. Furthermore, all respondents who work with VDU for 5-7 hours are found to be at low and medium risk of WMSD but 14 of respondents who were at high risk of WMSD are those who work with VDU for more than 8 hours. The study also revealed that 100% of the respondents who work more than 8 hours at VDU terminal are having musculoskeletal discomforts symptoms in lower back as well as shoulder. This result is similar to Hernandez et al. (2003) who concluded that VDU usage hours increase the risks of WMSD. Besides, these results also matched with previous study who determined that the risk of WMSD among workers are influenced by working hours with VDU (Robertson et al., 2013; Piranveysseh et al., 2016; Cho et al., 2012; Mahmud et al., 2014; Mozafari et al., 2015). Fig. 1 expresses the WMSD prevalence (divided into body reign) based on the daily VDU usage hours.



**Figure 1 MSD Prevalence According to VDU Usage Duration**

In terms of risk-level towards WMSD, the analysis determined that the respondents experienced higher WMSD risk when they work longer with VDU. A total of 176 respondents who work 5-7 hours with VDU, and 77 of them at the low risk-level of getting WMSD whilst the remaining 99 respondents are at medium risk-level. On the other hands, 87 respondents who work with VDU for more than 8 hours daily are at medium risk-level, whilst, the remaining of 14 respondents who work using VDU for more than 8 hours a day were at high risk level of getting musculoskeletal diseases. These results are depicted in Table 5. From the results, it could be said that the level of WMSD risks among the respondents is depend on the duration of VDU usage. This finding matched with Wu et al., (2012) who found in their research that daily VDU use had a significantly elevated the odds ratio for musculoskeletal complaints in comparison with nonusers.

**Table 5 WMSD Risk Level According to VDU Usage Duration**

Duration of computer usage	Low Risk	Medium Risk	High Risk
< 5 hours	0	0	0
5-7 Hours	77	99	0
≥8Hours	23	87	14

### 3.2 Inferential Analysis

Subsequently, ANOVA has been performed to determine the significant differences between WMSD risks on the body regions and VDU usage hours/ duration.

**Table 6 ANOVA Analysis for VDU Daily Usage Duration and Neck Risk**

		Sum of Squares	df	Mean Square	F	Sig.
Duration of VDU Usage	Between Groups	19.969	2	9.984	56.186	.000*
	Within Groups	52.778	297	.178		
	Total	72.747	299			

\* significant at the 0.05 level.

As expressed in Table 6, it could be stated that the difference between WMSD risk level towards neck and their working duration with VDU is statistically significant. Similarly, as depicted in Table 7, a statistically significant difference found between the duration of VDU usage and MSD risks towards shoulder among the office workers.

**Table 7 ANOVA Analysis for VDU Usage Duration and Shoulder Risk**

		Sum of Squares	df	Mean Square	F	Sig.
Duration of VDU Using	Between Groups	17.522	2	8.761	47.117	.000
	Within Groups	55.225	297	.186		
	Total	72.747	299			

\* significant at the 0.05 level.

The results of ANOVA analysis performed on VDU usage duration and WMSD risk toward lower-back also revealed a statistically significant difference. The result is depicted in Table 8.

**Table 8 ANOVA Analysis for VDU Usage Duration and Lower Back Risk**

		Sum of Squares	df	Mean Square	F	Sig.
Duration of	Between Groups	8.730	2	4.365	20.252	.000
VDU Usage	Within Groups	64.016	297	.216		
	Total	72.747	299			

\* significant at the 0.05 level.

Based on the results determined from the analysis, it could be stated that there are statistically difference between the hours of VDU usage and the risk of WMSD for shoulder, neck and lower-back among the respondents. Previous study also found that working with same position at long time could imposed to WMSD in low back and shoulder (Gopal, Thomas & Sreedharan, 2012). Moreover, Ming, Narhi and Siivola (2004) determined from their review study that intensive computer using had caused neck and shoulder pain. Hakala, Rimpela, Saarni and Salminen (2006) found that using computer at work for more than three hours is the threshold for neck and shoulder pain.

**Table 9 ANOVA Analysis for VDU Usage Duration Wrist/Hand Risk**

		Sum of Squares	df	Mean Square	F	Sig.
Duration of	Between Groups	19.720	2	9.860	55.227	.000
VDU Usage	Within Groups	53.026	297	.179		
	Total	72.747	299			

\* significant at the 0.05 level.

Furthermore, there is also a statistically different determined for the VDU usage hours and WMSD risk towards wrist or hand (Table 9). Lassen et al., (2004) found that continuous duration of keyboard using time were statistically significant for wrist/hand pain conditions. Borhany, Shahid, Siddique and Ali (2018) determine that computer usage caused WMSD at lower back, neck, shoulder as well as wrist and hand. Moreover, higher keying activation force, use of keyboard with the j-key >3.5 cm above the table surface, and increased radial wrist deviation during mouse use is found to predict hand/arm pain among workers (Gerr et al., 2002).

#### 4.0 CONCLUSION

It is known that computers, have unfortunately become a fundamental part of our daily lives. This study concludes that working longer with VDU could expose workers to high risk of WMSD among office workers. This paper has also revealed that the WMSD experienced by office workers in BPBSC is significantly different based on the hours they are working with VDU. This finding showed that the level of WMSD risk towards the body reigns among workers is different according to the usage hours of the VDU. Specifically, in BPBSC case, the length of VDU usage duration is significantly difference towards WMSD risk in neck, lower back, hand/wrist and shoulder body regions. This could be concluded in this study that the longer hours the workers work with VDU, the higher the risk of WMSD they are facing, specifically in those mentioned body reign. Thus employers shall take appropriate action in order to mitigate the risk and avoid musculoskeletal diseases among the workers. Promoting the ergonomic adjustments among workers and increasing the exercise during work (Ming et al., 2004), imposed mini break to the involving workers (Wu et al., 2012) and ergonomic training (Sirajudeen, Alaidarous, Waly & Alqahtani, 2018) are among the appropriate control measures that could be applied by the management of BPBSC in order to mitigate WMSD risks.

## 5.0 FUTURE RESEARCH

This research could be a preliminary empirical evidence for the management in terms of mitigating WMSD risks among the employees as well as controlling ergonomic hazards at their workplace. This research's findings also could contribute to the body of knowledge as an additional empirical evidence in ergonomic area. However, this research was limitedly conducted in BPBSC, therefore, the results could not be generalized. It is suggested that similar research should be expanded to other workplace in the same industrial sector. In addition, although this research has been conducted by an occupational health nurse and experienced OSH officers, an involvement of occupational health doctor in data collection, for example to verify the WMSD symptoms could increase the validity of the research.

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# Evaluation on Process Hazards Awareness in Handling Scheduled Wastes at a Urea Manufacturing Company

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**ABSTRACT:** *Toxic and hazardous wastes are defined in a schedule under the Environmental Quality (Scheduled Wastes) regulation 2005. Company A is a waste generator, thus, obliged to the regulation. Although awareness training has been conducted periodically, there are still recurring non-compliances. This research is to determine the process hazards awareness level of technical personnel in handling scheduled wastes for Company A via conducting a survey and detailed analysis on audit findings and training requirements. Target group of the study is Company A's technical executives. Sixty respondents (86%) completed the survey. The results shown that all respondents fully understand the characteristics of scheduled wastes on site. Misunderstandings were found in relation to method to reduce scheduled wastes, interpretation of pictogram for scheduled wastes and role and responsibilities of scheduled wastes handling and management. Five factors were identified as the main contributor towards the recurring non-compliances. Proposed interventions were executed and from weekly audit, no non-compliances observed after implementation for four consecutive months. It can be concluded that the proposed interventions are effective and confirmed that the study conducted has increased staff awareness on scheduled wastes hazards and risks.*

**Keywords:** *Non-Compliance at Workplace, Process Hazards Awareness, Scheduled Waste Awareness, Scheduled Waste Management, Training Requirements*

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## 1.0 INTRODUCTION

Scheduled wastes means any material falling within the categories of wastes listed in the First Schedule of the Environmental Quality (Scheduled Wastes) Regulations 2005 (Department of Environment, 2005). The criteria for scheduled wastes include metal and metal bearing wastes, wastes containing principally inorganic constituents which may contain metals, wastes containing principally organic constituents which may contain metals and inorganic materials, wastes which may contain either inorganic or organic constituents and any residues from treatment or recovery of scheduled wastes. There are 77 categories of scheduled wastes listed under the First Schedule of the Regulations (Department of Environment, 2005).

The toxic elements in scheduled wastes may be released to human and subsequently into the environment in three ways. Firstly, due to improper disposal of scheduled wastes, where scheduled wastes is normally disposed with municipal solid wastes and ends in non-hazardous landfill or is incinerated, and some are just dumped indiscriminately. Secondly, toxic substances are released into the environment through improper dismantling and precious material recovery processes, which release toxic substances into the air, soil and water; while the less precious (but highly hazardous materials) are disposed of in an unsafe manner. Thirdly, in relation to challenges faced in tracking down unlicensed or illegal scheduled

wastes recycling and material recovery activities. Due to the lack of appropriate methods and substructures, the workers and labourers working are fronting serious work related and health risks.

Having said that, many organizations face challenges to make the compliance programs pertaining to scheduled waste management sustainable. In a manufacturing company, regulatory compliance is among the key focus areas especially when it comes to health, safety and environment issues. Geddes (2017) claims that an organization that can mesh and implement compliance and integrity based ethics will have a strategic advantage over other businesses in the same industry. "Compliance needs integrity and integrity needs compliance" (Geddes, 2017). There are serious implications following a non-compliance including prosecution, exorbitant penalty cost or damage to reputation and brand. Yet, many organizations face challenges to make the compliance programs sustainable.

However, it is important to realize that an organization can technically has all the elements of a compliance program in other words the policies, the procedures and the training; but not actually has an effective culture of compliance. This is because full compliance is dependent upon the core ethical culture of the organization itself. According to the 2005 National Business Ethics Survey which found that employees in organizations with a weak ethical culture reported observing much higher levels of misconduct than employees in organizations with strong ethical cultures (70% compared to 30%) (Ethics Resource Center, 2005).

Furthermore, in measuring the effectiveness of a program, Richards (2007) suggested that the organization needs to think about measurements that include not just output, but that also include outcomes. In which, the organization not just measure the number of new surveillance reports, new training programs, new guidance provided to an organization's employees, but that organization also seek to measure the reduction or elimination of violations. In addition to that, Richards (2007) also suggested that there are five obstacles and pitfalls in improving an organization's culture of compliance which include lack of real management support, valuing risk-taking over all else, employees who do not understand the value or purpose of compliance obligations, lack of resources, and lack of constancy.

Richards (2007) suggested that education may help to emphasize that compliance is not about stifling risk-taking or profit-making, but about helping to ensure that risks are taken within the organization's tolerance for risk, and it may help to remind people that the organization and its franchise are bigger and more important than any one individual producer. He claimed that if the organization's employees do not affirmatively buy in to the value and the purpose of compliance, the compliance program would not be effective. Organizations that grab their employees' attention with real world examples of compliance issues by using videos, questions and answers, and other techniques seem to have a better chance at getting employees to understand and thereby to value compliance efforts. And, organizations that explain the underlying reasons for the compliance policies, and why they are good for the organization, do even better. Compliance education may be once a year, or may involve a big push in one area such as when new rules come out and then employees may never hear about the issue again. This is a common phenomenon in which we assume that if we tell people something important once, they will know it forever. Richard (2007) contends that this is just not true and in fact, repetition is key. For those provisions that rely entirely on behavioral compliance, there is a need to be very, very constant in delivering the message.

Apart from that, KPMG Risk Consulting (KPMG International Cooperative, 2016) also argued that compliance accountability starts with a strong culture of risk awareness with tone at the top, and reaches across the three lines of defence. The three lines of defence include business that is responsible for the design and execution of controls, compliance that oversees and implements the program to advise, challenge and assess compliance, and internal audit that provides the independent assurance of the first and second lines (KPMG International Cooperative, 2016). Apart from that, Cox (2007) also mentioned that leadership by example, good communication, and ongoing ethics education and training are all vital in setting up an ethical culture of an organization thus contribute towards overall culture of compliance.

Also, according to United States of America Department of Justice (2019) another hallmark of a well-designed compliance program is appropriately tailored training and communications. Prosecutors should assess the steps taken by the company to ensure that policies and procedures have been integrated into the organization, including through periodic training and certification for all directors, officers, relevant employees, and, where appropriate, agents and business partners. Prosecutors should also assess whether the company has relayed information in a manner tailored to the

audience's size, sophistication, or subject matter expertise. Some companies, for instance, give employees practical advice or case studies to address real-life scenarios, and/or guidance on how to obtain ethics advice on a case-by-case basis as needs arise. Prosecutors should also assess whether the training adequately covers prior compliance incidents and how the company measures the effectiveness of its training curriculum (United States of America Department of Justice, 2019).

As an organization that manufactures urea, Company A is part of the wastes life cycle as the wastes generator and thus, subjected to the scheduled wastes management regulation altogether. Even though scheduled wastes handling and management awareness training has been conducted periodically, there are still recurring non-compliances pertaining to scheduled wastes management at Company A such as unsealed wastes plastic bags kept next to equipment laydown area, insufficient cover causing rain water filled up wastes secondary containment, scheduled wastes and non-scheduled wastes are stored together, damaged bund wall which act as a wastes secondary containment and uncontrolled vegetation growth which caused blocked drainage leading to water accumulation. It is realized that there is a lack of understanding from technical personnel in the Company A on the process hazards of scheduled waste which leads to the recurring of non-compliances. The major problems on this issue is although many methods of awareness had been introduced and conducted in Company A, but non-compliances towards scheduled wastes handling and management practices still recurring. The other issue is that the top management of Company A does not directly address the compliance issues at site and need the justification to assess whether appropriate authority and accountability exists at all levels for compliance. It was strongly believed that by enhancement of measuring and promoting awareness attitudes of people on scheduled waste management could overcome any event or incident related to that issue. The quantitative survey conducted will gauge understanding on scheduled wastes hazards and its impact to health, safety and environment (SHE), investigate factors of non-compliances and propose recommendations to enhance scheduled wastes management program in Company A. This method will reduce the knowledge gap off all employee levels in Company A.

Although, compliance issues are a top concern for the Board and management committee of Company A, driving a growing cultural shift within the organization to view compliance risk management as an integral strategic investment is still a challenge by itself. Most of the time, the management failed to raise the real issues at site and ended up spending resources on secondary factors which does not directly address the compliance issues at site. In this case, the board needs to establish a strong tone at the top that demonstrates and communicates compliance as an investment. In addition to that, the management committee of Company A also needs to assess whether appropriate authority and accountability exists at all levels for compliance. There is a need for the management committee of Company A to receive regular and meaningful reports to understand the state of compliance at site in order to establish the right compliance culture. Thus, it is crucial to gauge the understanding of Company A's personnel at executive level on process hazards related to scheduled wastes handling and management in order to avoid non-compliances and prevent accidents from happening.

## **2.0 OBJECTIVE**

The objective of this study is to determine the process hazards awareness level of technical personnel in handling scheduled wastes for Company A via conducting a thorough quantitative survey on process hazards awareness of technical personnel in handling scheduled wastes for Company A. The key objectives of this evaluation is to gauge understanding from technical personnel of Company A on scheduled wastes hazards and its impact to health, safety and environment, investigate the factors that contributed to recurring non-compliances towards scheduled wastes handling and management practices, and propose recommendations to enhance scheduled wastes management program in Company A and execute timely implementation to prevent recurring non-compliances.

The results obtain from the survey is crucial to improve current compliance programs at Company A. This research will cover technical executives from four departments namely Health, Safety and Environment (HSE) Department, Technical Services Department (TES), Maintenance Department and Productions Department with a total population of seventy (70) personnel. The scope covered in this study are the demography of the technical executives, the awareness and understanding on scheduled wastes hazards and its impact to health, safety and environment. The important point analysed is the main factors contributed to recurring non-compliances towards scheduled wastes handling and management practices

by taking periodic audit findings and employees training requirement as an input. Finally, intervention measures were proposed in order to tackle the recurring non-compliances followed by implementation at site. For closing the loop, periodic audit was enhanced to weekly in order to ensure constant review and updates of compliant status at site and subsequently, drive adoption of compliant practices as part of the organizational culture.

The study is foreseen to increase awareness on Process Safety especially on scheduled wastes hazards and its impact towards health, safety and environment among technical executives in Company A. From literature review conducted, many literature covers only electrical and electronic waste management while very limited sources discuss in detail about industrial waste from manufacturing company. Thus, the manufacturing company often falls into a huge gap of identifying ideas and intervention plan to address compliance issues pertaining to scheduled waste management at site.

Hence, the output of this research will help personnel in the manufacturing industries, especially those in health, safety and environment capability to establish the focus area for them to troubleshoot on the main factors of recurring non-compliances towards scheduled wastes handling and management practices at their site. Personnel in the manufacturing industry fraternity may adopt the evaluation approach of using quantitative survey, periodic audit findings and employees training requirement as an input to gauge on the factors that contribute to non-compliance at site. Finally, intervention measures that were proposed in this research can be duplicated with some customization tailor made to specific company's framework in order to tackle the recurring non-compliances at site.

### 3.0 METHOD

The target group of the study was technical executives working in Company A from namely Health, Safety and Environment (HSE), Technical Services (TES), Productions and Maintenance Department. The choice was mainly due to the fact that the personnel from these departments were major scheduled wastes generators in which they contributed to 90% of the total amount of scheduled wastes generated overall. According to the 'Pareto Principle of 80-20 rule' by Dunford et al. (2014), by targeting to this group of people, it is expected that most of the issues related to recurring non-compliances that happened will be addressed. Overall, this study was using a plan, do, check and act (PDCA) cycle approach.

Simple random technique was used in sampling for technical executives in Company A which were segregated to respective departments (Health, Safety and Environment, Technical Services, Maintenance and Production Department) for ease of establishing intervention plan. When conducting probability sampling, it is important to use the appropriate sample size. For a total population of 70 pax, with confidence level of 95% and margin of error of 5%, the sample needed is 59 pax (Paul et al., 2019).

The study starts with establishment of safe handling of chemical and scheduled wastes procedure and overall yearly plan as part of Company A's environmental management plan, followed by conducting safe handling of chemicals and scheduled wastes management training to all relevant personnel.

During the execution of the plan, periodic audits were conducted to gauge on the effectiveness of current plan and to identify further opportunities for improvement. Three types of site audit conducted which include tier 1 audit on scheduled wastes management conducted weekly, Management Health, Safety and Environment (MHSE) audit conducted monthly and Mandatory Control Framework (MCF) audit conducted quarterly.

Following inputs from the weekly, monthly and quarterly audits conducted, a questionnaire was issued out prior to Company A's turnaround which was scheduled between October until December 2018. This survey questionnaire objective is to gauge the understanding on scheduled wastes handling and management of technical executives working in Company A in terms of real practice and available procedures at site.

The findings from the survey questionnaire were then analyzed in order to become an input for Company A's intervention plan. The intervention plans identified were executed as part of Company A's Strategies and Initiatives for the

turnaround. Throughout the turnaround duration, site audit was intensified to weekly in order to assess the effectiveness of the intervention plan proposed. The feedbacks acquired from all audits, survey and questionnaire were being consolidated to further improve Company A's environmental management plan and overall scheduled wastes management program.

#### 4.0 RESULTS AND DISCUSSION

From the survey conducted, four root causes were found to be related to the recurring non-compliances at site for Company A which include inadequate coverage of scheduled wastes handling and management training to all Company A's personnel, misunderstandings on the method to reduce scheduled wastes at site, misinterpretation of scheduled wastes pictogram on the waste collection area and unclear of the specific individual roles and responsibilities of scheduled wastes handling and management.

Six intervention plans were proposed and executed in order to tackle the root causes highlighted above include update and enhance the safe handling of chemicals and scheduled wastes management training pack to include specific individual role and responsibilities of safe handling of chemicals and scheduled wastes at site, replace scheduled wastes pictograms with actual scheduled wastes pictures at site, increase audit frequency from monthly to weekly, establish '*Collect and Redeem Program*' campaign, nominate focal person from each department and establish scheduled wastes minimization at source plan which identifies process operations that generated most scheduled wastes from the total inventory and subsequently conduct process parameters adjustments and lastly include scheduled wastes handling and management training as part of compulsory training requirement for all technical staff.

As part of the proposed intervention plan above, a scheduled wastes management Information to Public (ITP) session was conducted for all staff of Company A. A total of 389 personnel attended the session which covers 85% of total population of Company A's staffs inclusive of Executives and Non-Executives. Those who did not attend the session are identified from shift groups in which they are subjected to a more formal and structured training modules pertaining to safe handling of chemicals and scheduled wastes. Overall, the coverage of the session and structured training have reached 100% of the total Company A's staff population. Feedback form was issued out to gauge the understanding of Company A's staff on safe handling of chemical and scheduled wastes procedure and practices after the session.

From the feedback forms gathered, 97% agreed that the session has achieved its objective of increase awareness on safe handling of chemicals and scheduled wastes, iterating scheduled wastes hazards and risks as part of scheduled wastes handling and management program. 99% of the respondents agreed that scheduled wastes handling and management safety hazards and requirements have been effectively communicated and 97% of total population agreed that they understand clearly hazards related to safe handling of chemicals and scheduled wastes. Likewise, 98% agreed that proactive steps that need to be taken for safe handling of chemicals and scheduled wastes during scheduled wastes handling and management have been clearly explained and 95% of the total population said that all information that has been shared is clear and easily understood. Program effectiveness score has also increased from an average score of only 3.34 which is equivalent to 67% to an average score 3.43 which is equivalent to 86%.

In accordance to the root cause of inadequate coverage of training, Charles (2005) claimed that a culture of compliance is evidenced by people working toward common and understood goals, with clear and consistent communication, efficient monitoring and reporting, and decisive action to investigate anomalies and take corrective action as needed. The survey results support this statement by showing significant correlation between an increase in process hazards awareness (from 67% to 86%) and reduction of non-compliance cases (from five cases every month to zero cases within the duration of four months). Apart from that, the survey results also support the presumptions from Charles (2005) that culture of compliance is evidenced by people working toward common and understood goals where it was observed there was an abrupt reduction in number of non-compliances at site when common goals has been established and expectations are clearly communicated across. By changing the scheduled wastes pictogram into real pictures, the respondents can directly relate on the hazards and risk of mishandling scheduled wastes to their health and safety and thus work together to fully comply to the requirements stipulated in the Company A's work procedure.

Apart from that, Richards (2007) claimed that if the organization's employees do not affirmatively buy in to the value and the purpose of compliance, the compliance program would not be effective. From the survey, the buy in of personnel in Company A was enhanced by reiterating the roles and responsibilities related to scheduled waste handling and management via enhancing relevant training materials for all personnel that involve in scheduled waste handling. Apart from that, the training pack was also enhanced by using real pictures of scheduled wastes at site instead of pictograms. The hazards and impact of scheduled wastes to personnel health was highlighted precisely in the training pack to nurture culture of compliance. This is to create common understanding towards the importance of compliance when it comes to scheduled wastes handling and management in Company A. As a result, Company A establishes a common goal which leads to outstanding results of zero non-compliance for five consecutive months after all intervention plans executed.

Also, Richards (2007) suggested that the organization needs to think about measurements that include not just output, but that also include outcomes. In which, the organization not just measure the number of new surveillance reports, new training programs, new guidance provided to an organization's employees, but that organization also seek to measure the reduction or elimination of violations. In this study, this was achieved by improving the frequency and effectiveness of periodic audit from monthly to weekly in order to measure the reduction or elimination of violations once the intervention plan has been executed. By having a weekly audit on scheduled wastes handling and management with no further non-compliances observed in the month from October 2018 until February 2019, this can confirm that an increase in site surveillance frequency may improve hazards awareness of relevant personnel.

In short, this can conclude that the survey with its intervention plan execution has positively improved the scheduled waste handling and management awareness for all personnel in Company A. However, in order for this improvement to sustain, the training to all relevant personnel of Company A has to be repeated periodically for it to become an embedded safety culture in each and every one of Company A personnel. Employees in organizations with a strong ethical culture were more likely to report the misconduct than those in weak-culture organizations (79% compared to 48%) according to Ethics Resource Center (2005). This will over time reduce and eliminates the misconduct or non-compliances altogether.

In addition to that, Richards (2007) also suggested that there are five obstacles and pitfalls in improving an organization's culture of compliance which include lack of real management support, valuing risk-taking over all else, employees who do not understand the value or purpose of compliance obligations, lack of resources, and lack of constancy. It is crucial for Company A to follow through the implementation of the proposed intervention plan with continuous improvement initiatives so that the intervention program remains relevant and zero non-compliances can be sustained.

## **5.0 CONCLUSION**

In summary, the survey conducted in Company A on evaluating the process hazards awareness of handling scheduled wastes have reached the targeted audience with 95% confidence level. The root causes for non-compliances identified and the intervention plans proposed were executed in October and November 2018. Based on the observations from periodic scheduled wastes audit which frequency has been revised from monthly to weekly, there is no non-compliances observed with regards to scheduled wastes handling and management from the month of October 2018 until February 2019. Therefore, it can be concluded that the proposed intervention plan has reached its objective and targeted audience. This confirms that the "Evaluation on Process Hazards Awareness in Handling Scheduled Wastes at a Urea Manufacturing Company" has increased staff awareness on scheduled wastes hazards and risks on health, safety and environment and at the same time has reduced and minimized incidents and non-compliances at workplace for Company A.

Recommendations are to extend this evaluation study to contractors of Company A's so as to get a correct impression of the actual implementation at site on safe handling of chemicals and scheduled wastes. Correspondingly, the intervention plans that has been executed need to continue so as to have a sustainable implementation and safety performance at site. Some limitations of the study include limited coverage of the population samples which target only to technical executives of Company A. Thus, the study will be confined to the Process Safety culture of the particular company of study and might not be applicable to the public at large. Further customization is needed if the similar quantitative evaluation is to be conducted to a different group of people.

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## Survey on Pandemic Preparedness Plan (PPP) among Malaysian Corporate Health Advisers' Forum (MCHAF) Members

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**ABSTRACT:** *The Covid-19 outbreak has increased the interest in Pandemic Preparedness Planning. A survey on this subject was conducted among MCHAF members. Nine companies participated in the survey. The industries represented were aviation, chemical, electronic, healthcare, manufacturing, oil and gas, social services and utilities. All of them had a pandemic plan. The plan of most companies covered work restriction (77.8%), communication plan (88.9%), stockpiling masks during peacetime (66.7%) and the roles and responsibilities of various departments (100%). Most plans however did not cover stockpiling on antivirals during peacetime (66.7%). There was a variety in ownership of the PPP, essential components of the plans, where the plan was adopted from, main concerns and advice. Among the concerns shared were: differences in directives and leadership mindset, need for rapid response, lack of preparedness i.e. no mock drill conducted earlier, logistic challenges, i.e. getting PPE and conducting business, estimating adequate PPE supplies and countering inaccurate information. Advice given include: conduct risk assessment and respond accordingly, align with the local ministry of health and company directive; familiarize leaders with the PPP and conduct mock drills, close monitoring of the situation and timely communication. We believe that the knowledge and understanding on PPP from this study can be used by companies to enhance their PPP.*

**Keywords:** *Health Adviser, Industry, Occupational Health, Pandemic Plan, Preparedness*

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### 1.0 INTRODUCTION

A pandemic is the worldwide spread of a new disease (World Health Organisation, 2010). Influenza pandemics are unpredictable but recurring events that can significantly affect health, communities and economies worldwide. Planning and preparation are critical to help mitigate the risks and impacts of a pandemic, and to manage the response and recovery. Knowing who will do what, when, and with what resources is critical to managing a pandemic situation. Successful operations occur when stakeholders know their roles and responsibilities, understand how they fit into the plan and how to work together, and have the capacities and resources to implement the plan (World Health Organisation, 2018). Although pandemic preparedness is often associated with influenzas, it may also be due to other viruses. The current concern is that Covid-19, which is not an influenza virus, may result in a pandemic.

Among the aspects that need to be addressed at the workplace include pandemic preparedness and response plan, communication, antiviral medication, facemasks, temperature screening and health declaration, cleaning and disinfection measures, vaccination, travel health and medical leave (Jefferelli *et al*, 2009).

PPP contents and implementation are often based on local and company advice and guidance which are developed by agencies such as the Health Authorities in Malaysia (Ministry of Health Malaysia, 2006; Ministry of Health Malaysia, 2020), National Council for Occupational Safety and Health (2020) and Professional bodies (Ministry of Health Malaysia & The Society of Occupational and Environmental Medicine of the Malaysian Medical Association, 2006). Advice from Health Authorities outside Malaysia (Ministry of Health Singapore, 2014; Food and Health Bureau, Department of Health, Centre for Health Protection, Hong Kong, 2020) may also be considered. The health advisories may differ based on the nature of health pandemics and hence there is a need to review the existing PPP to suit the pandemic of concern.

In view of the Covid-19 outbreak, there was an increased interest in PPP among organizations. This included the Malaysian Corporate Health Advisers Forum (MCHAF), an informal group of occupational health doctors in Malaysia who serve the various industries. Among the industries represented are aviation, chemical, electronic, healthcare, manufacturing, oil and gas, social services and utilities.

## 2.0 METHOD

In February 2020, MCHAF members were invited by e-mail to share their responses to a brief survey in word format on PPP. The survey form was newly developed by the two authors based on what they felt were questions that would be of interest and relevance to MCHAF members. Some of the questions were open ended and some were binary i.e. 'yes' or 'no'.

## 3.0 RESULTS

### 3.1 Respondents

Nine MCHAF members responded to the survey. The response by the industries are as follows: aviation-1, chemical-1, healthcare-2, manufacturing-1, mixed-1, oil and gas-1, social services-1 and utilities-1.

### 3.2 Response

#### 3.2.1 Does your Company Have a Pandemic Plan and What Does the Plan Define?

All companies have a pandemic plan. The plan in most companies covered work restriction (77.8%), communication plan (88.9%), stockpiling masks during peacetime (66.7%) and roles and responsibilities of various departments (100%). Most plans however did not cover stockpiling on antivirals during peacetime (66.7%).

**Table 1 Does your Company Have a Pandemic Plan and What Does the Plan Define?**

Question	Response (Number and Percent)		
	Yes	No	Total
Does your company have a pandemic plan?	9(100)	0(0)	9 (100)
Does plan define:			
Work restriction?	7(77.8)	2 (22.2)	9(100)
Communication plan?	8(88.9)	1(11.1)	9(100)
Stockpiling masks during peacetime?	6(66.7)	1(33.3)	9(100)
Stockpiling antivirals during peacetime?	3(33.3)	6(66.7)	9(100)
Role and responsibilities of various departments?	9(100)	0(0)	9(100)

### 3.2.2 Ownership of PPP

There was a variation in the ownership of the PPP which included: Emergency Management; Health; Health Safety Security and Environment; Human Resource; Medical Affairs and Quality; National Crisis Management Team; Risk Division and Safety and Health Committee and senior executive of the operation site.

### 3.2.3 What Other Essential Component Does Your Plan Include

Other essential components included were: preventive and mitigating measures; pandemic threat and impact assessment; Standard Operating Procedure for disease outbreak, detailed action plan for operation stockpile of personal protective and potential source for emergency supply; travel restriction policy; disinfection procedure; visitor or employee screening process; emergency deployment of employees performing essential services; employee sickness surveillance; agile work arrangements; business continuity plan; supply chain risks; and Crisis Incident Management team and pandemic control team.

### 3.2.4 Where is the Plan Adopted From

The plans were adopted from various organisations including: The Collaboration Arrangement of Public Health Events in Civil Aviation (CAPSCA) Forum, the Joint Commission International (JCI); Ministry of Health Malaysia; Ministry of Health Singapore; individual Corporate Guidance; the University of Pittsburgh Medical Centre; and the World Health Organisation.

### 3.2.5 Main Concerns

The main concerns were: need for rapid response to a new disease; organizational preparedness to enable effective response; did not conduct mock drill of different pandemic scenarios during peace time; new directives, i.e. need for exit screening due to destination countries ad-hoc health directive; managing related logistics; Standard Operating Procedures (SOP) that were operational centric rather than holistic; leaders are either over anxious or cautious, have different risk appetite at different sites within the same organization or are not familiar with the pandemic plan; insufficient stockpiling during peace time; differing practices in different countries and unauthorised information being circulated.

### 3.2.6 Main Advice

The main advice was: to conduct a risk assessment of the situation; tailor the plan according to your organizational needs; align plan with the Ministry of Health Malaysia and individual company directives; have simulation exercises involving senior executives so that they are familiar with the pandemic preparedness plan and risk mitigation measures, and are able to drive decision making; have a crisis response team and committee that can make evidence-based decisions; understand the local pandemic preparedness plan of the respective country as the level of preparedness varies among countries even though both countries may be under the same WHO alert level; closely monitor the situation and update plans; and have periodic communication with respective stakeholders.

## 4.0 DISCUSSION

### 4.1 Respondents, Whether Company Has Plan and Whether Key Aspects Covered?

Despite the relatively small sample size, it represents a wide range of industries. Since MCHAF members represent large organizations, it was not surprising that they all had a pandemic plan. Most plans covered important aspects such as work restriction, communication plan and responsibilities of various departments. It was interesting that one third of the plans did not specify stockpiling masks during peacetime because mask use is often seen as an important prevention measure for pandemics and it is difficult to obtain masks once a pandemic has been declared. Most of the plans did not cover stockpiling of antivirals which is aligned with the general thought that stocks are not required by industry. Among the reasons are that at preparedness stage it is often unclear if and what type of antivirals would be effective against the circulating virus. Another

point is that the antivirals have an expiry date and if not used would have to be disposed. However, two of the respondents were from the healthcare sector and their plans did include stockpiling of antivirals.

#### 4.2 Ownership of PPP

The variety of parties owning PPPs reflect the diversity in approach among the different organizations. Such parties are deemed as the most appropriate by their organizations to lead in such matters. However, they will still need to work closely with other key team members such as health, human resources, safety and operations.

#### 4.3 What Other Essential Component Does Your Plan Include?

Apart from key components such as the communication plan, stockpiling masks and role and responsibilities of various departments there were many other elements included in pandemic plans. These ranged from elements such as detailed action plans to disinfection procedures, visitor and employee screening process to business continuity plans. Many organizations have an overarching Crisis Management Plan (CMP) in place. Some companies would cross-refer to elements in CMP and not duplicate such elements in their PPP. However, some may prefer a complete standalone document and hence mention such elements in PPP too. Others may also feel the need for a different approach in a pandemic. For example, the company physician may not be included as member of the incident management in CMP but included in their PPP. Essential elements in PPP also depend on the type of industry. For example, elements required in the aviation industry such as provision of meals to passengers onboard flights would differ from the healthcare industry which would need to ensure stocks of medication.

#### 4.4 Where were the Plans Adopted from?

Company PPPs were adopted from a variety of sources. WHO, MOH Malaysia and individual company guidance were common resources for all members. For certain industries, industry specific guidance i.e. JCI and CAPSCA were available. It was interesting that some companies also referred to overseas MOH and medical centre practices.

#### 4.5 Main Concerns

The concerns raised were understandable. When there is a new disease causing a pandemic there are often new directives and rapid response required. There could be doubts on the organization's ability to respond effectively especially if they did not optimise preparedness measures such as conducting mock drill for similar scenarios. Companies will also need to manage the logistic challenges not only in obtaining the related PPE, but in running their normal business operation. The company's SOPs can be operational centric and not cover aspects not directly related to operations such as support team members. Leaders differ in mindset, perception and experience when dealing with crises and pandemics, even in the same organization. This would explain the difference in risk perception among them. There is always a need to be objective in risk assessment to reach a well-balanced assessment of the situation and decision on actions to be taken. Leaders are usually very busy, responsible for and engaged on multiple issues and hence may not have familiarized themselves with their pandemic plan. It is difficult to estimate the stockpiles that would be adequate. Among the factors that would influence this include measures recommended by authorities, availability of stocks in the market and estimated duration of pandemic. Health departments in different countries may give advice in different countries and this can be difficult to explain to employees especially if the company has employees in these different countries i.e. some countries may require use of mask in public whereas others do not. Another challenge in the age of digital era is the quick and wide spread of unauthorised information which could result in wrong perception and panic among the population.

#### 4.6 Main Advice

Good advice on PPP were given by members. As for any crisis, risk assessment of the situation needs to be carried out and plans need to be suited to organizational needs. To ensure the plan is effective and accepted, it is also important that it is aligned with the Ministry of Health, Malaysia and individual company directives. Leaders need to be familiar with their PPP and simulation exercises during peacetime would facilitate this. In a crisis, the crisis management team will make important decisions on measures to institute. It is important that there are members in this team who will be able to convincingly share relevant evidence and for the members to fully consider it when making decisions. The crisis management team should also understand the difference between local alert levels and worldwide levels. In view of the rapid change in situation, close monitoring is required. Periodic communication is also important to ensure stakeholders are aware of the latest developments and continue to receive authentic information.

#### 5.0 CONCLUSION

This study shows a variety of approaches and resources for PPP. It also shares the concerns and advice on PPP. It should add to the knowledge and understanding of this topic and be used by companies to enhance their PPP.

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## Book Review

# Book Review: Workplace Innovation: Theory, Research and Practice – Aligning Perspectives on Health, Safety and Well-Being by Peter R.A. Oeij, Diana Rus and Frank D. Pot

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## 1.0 INTRODUCTION

‘Workplace Innovation: Theory, Research and Practice’ is targeted at a broad group of readers, namely policy makers, scientists and researchers, as well as workplace innovation practitioners such as representatives of employers and employees. This book also offers important practical contributions to solve a major set of new challenges in our global economy relating to psychosocial wellbeing at work.

The nature of work has changed significantly during the course of human history. However, the pace of this change has accelerated in recent years, largely due to digital technologies. New technologies are already affecting job definitions and work patterns. They are transforming the relationship between employers and employees, the organization of work, and the types of business models used. Many of today’s jobs and skill profiles did not exist a decade ago, while routine tasks are often vulnerable to automation or system. Competitiveness, flexibility, faster and faster time to market, continuous customized product innovation are characteristics of today’s organization challenges.

The need for Workplace Innovation (WPI) is obvious and enormous, but until now, it has mainly been excluded from the public, and technology-driven debate. This book contains 5 main parts; 1) policy, 2) theory matters & evidence, 3) research, 4) practice, and 5) conclusion. The book answers various fields to shed light on the question ‘what is the meaning of workplace innovation for?’, respectively for science, policy makers, employers and employees. WPI approach is to help employers improve productivity, create better products, and improve the health and well-being of the workforces.

## 2.0 CONTENT

What is WPI? It can be defined as evidence-based organizational or workplace practices and cultures which enables employees at all levels to use and develop their skills, knowledge, experience, competencies and creativity to the fullest possible extent, simultaneously enhancing business performance, engagement and well-being (Workplace Innovation Europe, 2020). It builds organizations in which people come to work to do two things; to undertake their functional tasks in the most effective way possible and, to improve and innovate the business and organization.

Such workplaces are likely to include empowering job design; self-organized team work; open and fluid organizational structures; delegated decision-making and simplified administrative procedures; a coaching style of line management; regular opportunities for reflection, learning and improvement; high involvement innovation practices; the encouragement of entrepreneurial behavior at all levels; and employee representation in strategic decision-making. WPI can lead to significant and sustainable improvements both in organizational performance (OP) and in employee engagement and wellbeing.

Part 1, for policy topic, WPI is gaining a higher profile as an emerging European policy embedded in a broader economic and social profile European Union (EU) policy to support organizational change in companies. The authors suggest that today's digitalization and robotisation offer opportunities for a more integrated EU policy. For example, the German Industry 4.0 policy to stimulate innovation, notably in smart and advanced manufacturing.

In industries throughout the world, there is a growing attention to **Vision Zero (VZ)** program - the ambition and commitment to create and ensure safe and healthy work and to prevent all serious accidents and occupational diseases in order to achieve zero harm. VZ has recently developed into a major issue in national and international policies for promoting occupational safety and health. Simply doing the same things better than before, is not a successful strategy to achieve zero harm or incident. Both technical and social innovations are needed as well as out-of-the-box thinking for solving existing problems. Zwetsloot et al. (2017) suggests six innovative perspectives of VZ as in Fig. 1 below:



**Figure 1 Six Innovative Perspectives of Vision Zero (VZ)**

In theory and evidence, WPI promises to improve organizational performance, quality of the working life and, consequently, wellbeing at work simultaneously. There is an emphasis on improving wellbeing via individual coping behavior. The book succeeds to explain the importance of WPI implement in the organization for business sustainability as well as appreciating the most valuable asset in the organization, its people. The discussion contributed to this result by highlighting the overlap and commonalities in theories of wellbeing (WB) balance and WPI in the workplace. It ended with a few recommendations for future research and practice.

The research found out that there was a significant relationship between WPI and Work & Organizational Psychology (WOP) as well as job flexibility, quality of working life (QWL) and organizational performance (OP). Successful WPI implementation results from an interplay between management-driven business goals and employee-driven quality of work goals. One of the key success factors is constructive co-operation between management, employees and employee representatives. The whole-system approach focusing on the interplay between strategy, structure, and culture is most likely to lead to successful WPI implementation.

Meanwhile, there are five steps to develop WPI; 1) Why WPI, 2) A systemic approach, 3) Starting the change, 4) Guide to the elements, and 5) The process of change. WPI not only aims at fostering innovation capacities, it also allows businesses to remain innovative and adapt to change more quickly and smoothly. One of the WPI example is the Innovation Resilience Behaviour tool (IRB-tool), aimed at improving teamwork as an example of workplace innovation intervention (Fig. 2). The IRB-tool is mainly a diagnostic tool to assess the present situation regarding three aspects:

- 1) the presence of defensiveness, and thus insight into possible causes for risk-avoidance;
- 2) the presence of mindful infrastructure, that is, characteristics that facilitate IRB; and



- 3) the presence of IRB - the behaviours and competences to keep an innovation team on track and to get it back on track.

The primary advantage of applying the IRB-tool is the opportunity to boost entrepreneurship, intrapreneurship and innovation within the organization. The tool and its theoretical underpinnings reflect the vision that innovation requires employee participation. The tool basically deals with improving problem-solving behavior, and this could be relevant to other types of teams, to project management in general and to any project-based organization.

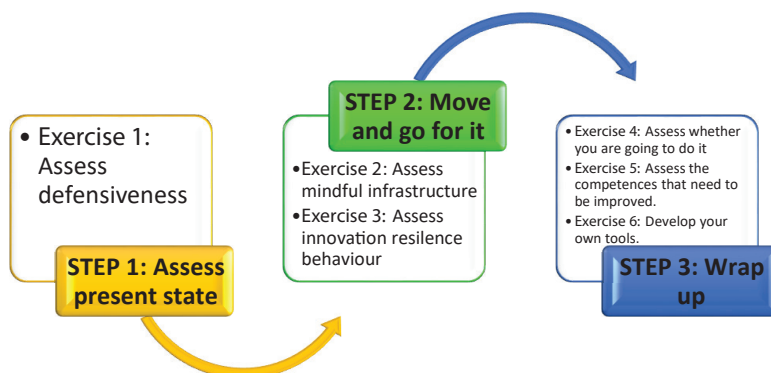


Figure 2 Framework of IRB-Tool: Step and Exercise

### 3.0 CONCLUSION

This book explores how WPI contributes to improving wellbeing at work and organizational performance. It also discusses the current state of European and national policies on workplace innovation, novel theoretical approaches to WPI, as well as international WPI case studies, and practical tools for the implementation of WPI. The summary of important statements from the book are:

- 1) Successful WPI implementation results from an interplay between management-driven business goals and employee-driven quality of work goals;
- 2) A consistent approach to shared leadership can stimulate employee empowerment and bottom-up, which, in turn, leads to successful WPI interventions;
- 3) Lean management methods can only be a successful tool for WPI if employees are actively involved in the process;
- 4) WPI should include the aspect of QWL otherwise low employee engagement will be the consequence; and
- 5) Institutional alliances are relevant for the sustainability of WPI activities within companies.

### 4.0 RATE THE BOOK

Book reviews with star ratings can be more effective, compared to those which don't. Though this is entirely optional. I used a scale of 5 in the increments of 1; a) 1 Star – Complete waste of time, b) 2 Stars – Fine but not happy with it, c) 3 Stars – Satisfactory, not too bad, d) 4 Stars – Loved reading it and e) 5 Stars – Impactful (Writoscope, 2021).

The author thoroughly researched the topic before writing. This book is explaining the basic concept and practice of workplace innovation, an evidence-based approach to organizational transformation that leads to high performance and enhanced workforce engagement and wellbeing. Therefore, I rate this book 4 stars.

In my opinion, it needs to relate and give more practical example to safety and health impacts to the workplace and employees. There will be new emerging hazards and risks since the work process, facilities and surroundings change. Employers prefer the easiest and lowest cost control measures after measuring the effectiveness in short and long term periods to overcome the hazard at the workplace (M. E. Baruji et al., 2020).

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The book review was written by Ts. Hj. Mohd. Esa bin Hj. Baruji, Technical Expert (Principle Consultant/ Researcher), NIOSH, Malaysia who is a registered professional technologist with the Malaysia Board of Technologist (MBOT), he possesses more than 20 years of OSH experience. The author declares that he has no conflict of interest with the book publication.

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