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Journal of Occupational Safety and Health

The Journal

- Aims to serve as a forum for sharing research findings and information across broad areas in occupational safety and health.
- Publishes original research reports, topical article reviews, book reviews, case reports, short communications, invited editorial and letter to editor.
- Welcomes articles in occupational safety and health related fields.

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Introducing the Journal of Occupational Safety and Health

The National Institute of Occupational Safety and Health (NIOSH), Malaysia 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

Ensuring workplace safety is of utmost importance. Despite progress in promoting safety culture and awareness, there is room for improvement. We must remain committed to take action and implementing necessary changes to make safety a top priority for everyone.

NIOSH is engaging with the committee through an authentic way of disseminating research and development output through our Journal of Occupational Safety and Health (JOSH).

For this edition, one of the paper is focusing on the implementation of Behavior-Based Safety (BBS) in the construction industry, which requires ongoing efforts to achieve greater safety performance. The paper calls attention to the adoption of BBS practices that can promote a safer work environment by reducing hazardous incidents, creating a safer environment, encouraging teamwork and commitment to safety and encouraging employees to plan safe work settings by observing their colleagues' work habits. However, employers may encounter challenges in designing and implementing effective behavioral safety sessions that promote safety precautions, especially when working with a diverse range of workers with varying learning levels and styles. The research identified eight factors to assess the effectiveness of BBS programs and concluded that companies implementing BBS have a better understanding of safe behaviors and perform better in this regard than those that do not.

The National Institute of Occupational Safety & Health (NIOSH) holds the mission to publish the journal's content to reach a broad academic audience by promoting and providing a platform for discussing matters related to OSH. As such, we hope to accumulate the wealth of experiences that can be drawn upon by readers. Our objective is to make the journal beneficial to all, across various industries focusing on issues relevant to everyday practices. I would like to extend a warm welcome to all readers and contributors to JOSH (Vol 20, No. 1). We look forward to receiving more contributions from the Malaysian OSH community for future issues.

Haji Ayop Salleh
Chief Executive Editor

Original Article

Evaluation of the Role of Behaviour-Based Safety in Construction Industry Employees' Safety Perceptions

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ABSTRACT: *Behaviour-based safety (BBS) is a scientific approach to understanding and altering human behaviour in the workplace to improve safety performance. Good behaviour at work increases efficiency, reduces accidents, and contributes to project success. This study investigated how construction workers' perceptions of the work environment may affect their understanding of behavioural safety through BBS. The hypothesis and questionnaire were developed based on 8 factors derived from literature and interviews with safety experts. Data were obtained from 132 construction employees from companies applying and not applying for BBS in Malaysia. A one-way multivariate analysis of variance test was used to examine the study hypothesis. The results indicated significant differences in employee safety perception between companies applying and not applying for BBS. We believe that our results will encourage industry experts to apply, review, or amend their safety behaviour programs.*

Keywords: *Behaviour-Based Safety, Construction Industries, Employee Safety Perception, Safety Performance*

1.0 INTRODUCTION

A secure work environment is necessary in today's industry. Generally, industries are working on improving construction and methods. The construction industry invests in machinery, infrastructure, procedures, standard operating procedures (SOPs), systems, and other tools. These elements are essential for building a complete safety system. However, these basics are still insufficient. To ensure long-term sustainability of the safety system, the human power aspect of the system must be considered. Even strong safety hardware has limitations that require huge resources for support. Yet, software aspects such as procedures and SOPs are inexpensive and easy to develop but rely heavily on users. Hence, the impact of safety and health relies upon human power that is abandoned at the bottom of the pyramid where the employees are exposed to actual threats and risks. Human behaviour is important for those who work to decrease the number of accidents and foster safe performance in the work environment (Basu, 2018).

The behaviour-based safety (BBS) program helps facilitate safety behaviour. The BBS is the technical function of psychological study of the problem of human safety behaviour (Cooper, 1994). Accurate goal setting, systematic observation of safety-related behaviour, and preparing appropriate feedback together with training can increase overall safety behaviour (McAfee and Winn, 1989). A combination of goal setting and feedback is far superior to feedback alone, and cooperative goal setting is more productive and successful than assigned goal setting (Duff et al., 1994; Li et al., 2015).

The evaluation of preceding accidents suggests that the usual overall performance of complex sociotechnical structures is primarily based on interactions between human, organizational, managerial, technical, social, and environmental factors. Human and organizational aspects are increasingly recognized as integral problems through high-reliability organizations, normally in relation to preventing explosions, fires, structural screw-ups, or other operational accidents. For high-reliability organizations, the connection between near misses and critical incidents is essential; for these organizations, even curiously insignificant blunders or small errors can combine to pose a vital hazard to the organization, humans, and surroundings (Robertson et al., 2016). Different interoperations exist for the term human factor. Gordon (1998) described human factors as a link between humans and machines. However, this explanation has been improved to include the effects of organizational, group, and individual factors on safety. According to the United Kingdom (UK) Health and Safety Executive, "human factors refer to environmental, organizational, and job factors, and human and person characteristics, which affect behaviour at work in a way which can have an impact on fitness and safety." This definition focuses on three interrelated factors that should not be neglected: the organization, individual, and job. In particular, human factors are involved with what people are being requested to do (the jobs and their features), who is performing it (the individual and his/her capability), and where the people are doing it (the organization and its features); all elements are affected by broader social concern (locally and internationally) (The UK Health and Safety Executive, 2020).

McSween (2003) claimed that human safety attitudes change when we can first change our safety habits, particularly as our colleagues undertake improved safety habits. We can discuss people with a common safety culture once we ensure that there is a group of people with related habits and attitudes towards safety. If we want to point out changes in safety culture, we need to discuss changes in people's behaviour (McSween, 2003). In fact, behaviour is external, observable, and an active experience, whereas attitude is internal and refers to thinking and realization. Safety behaviour refers to employees' personal behaviours to develop the safety and health of their workplace (Lee et al., 2017). Over the years, approaches to minimize unsafe behaviour have been increasing. Many researchers (Cooper, 1994; Lingard and Rowlinson, 1997; Zhang and Fang, 2013; Choudhry, 2014; Jasiulewicz-Kaczmarek et al., 2015; Li et al., 2015; Guo et al., 2018) have used the BBS model to develop employees' safety behaviour, reduce accidents, and increase safety performance. In the BBS model, good safety training has a crucial impact on employee safety behaviour. Regarding the particular field of safety training, study on its impacts appears to have almost continuously been intentioned on behavioural criteria or focused on injury reduction.

Generally, the goal of the BBS method is to improve safety for reducing industrial injuries by combining behavioural science, quality, and improving organizational principles with safety management (Krause, 2002). Salem et al. (2007) investigated two key aspects that improved the BBS in comparison with other approaches:

1) It concentrates on workers' behaviour, which is considered to be the main cause of injuries and illness.

2) It inspires workers' participation in safety matters, as safety is not the only responsibility of management.

Based on the aforementioned aspects, BBS is an essential section of occupational health, safety, and environment, and the community's goal is to improve performance consistently. According to Occupational Health and Safety Assessment Series (OHSAS): 18001, all businesses have to implement a proper method of human safety behaviour elements with the beneficial involvement of all personnel; therefore, they are aware of recognizing and controlling risks at the workplace (subsection 4.4.3.2) (OHSAS, 2007). Observation accuracy is essential in alterations of at-risk behaviours; hence, personnel should be aware and have knowledge about their jobs, risks, SOPs, the process involved, etc. The objective of a BBS program is to change unsafe behaviour to safe behaviour among co-workers in the workplace. Kaila (2016) believed that the important learning issues of implementing BBS in industries are as follows: every educated worker is a BBS mentor, identifying dangerous acts or conditions is a regular activity, incidents due to observer well-time intervention are reduced, safe behaviour becomes a part of the worker, and BBS is the foundation for sustaining Occupational Health and Safety Management Systems with regard to generating a work environment. BBS is a practical safety method, and its results can be presented as monthly feedback to all personnel (Kaila, 2016).

Abere et al. (2017) researched the intervention effects of a BBS program at pipeline operation sites. They found that applying BBS decreased the range of recordable safety incidents. behaviour-based feedback improved scores of the safety percentage from baseline to the intervention, and these enhancements were maintained for numerous ranges of workers at different sites. The stress of outside work issues influences workers' productivity and fear of reporting risky acts and conditions, because blaming the system and probable punishing actions may affect safety behaviour. Thus, Abere et al. (2017) suggested maintaining a BBS program by applying peer-to-peer observation of employees' safe and unsafe behaviour, teaching, and providing feedback, thereby gaining trust and increasing the level of safety culture and performance.

Ting et al. (2020) worked on an adjusted BBS program to mitigate construction accident rates among international engineering contractors. They claimed a different observation system in the adjusted BBS compared with the traditional BBS observations. In the adjusted BBS program, frontline workers do monitoring as part of their job tasks. Increasing workers' involvement in this safety-related behaviour program improves their safety knowledge, and managers are able to have more realistic data on workers' behaviour, which is very important for preventing accidents.

Abbasi (2018) emphasized the role of BBS in risks in the mining industry. Abbasi (2018) argued that at-risk behaviour is the main reason for many injuries and that improving employees' safety behaviour will prevent injuries and accidents. However, she introduced five other advantages that result from employees contributing interdependently to an effective BBS program as follows: 1) it emphasizes the evaluation of accurate numbers; 2) it creates a positive attitude; 3) it improves individual accountability for safety; 4) it allows interpersonal teaching and cooperation; and 5) it promotes and educated structures thinking.

According to the aforementioned literature, it can be concluded from the researchers' study that BBS focuses on personnel and their involvement in a safe work environment by observing and teaching them when they are doing safe or unsafe. It can be an important part of a larger safety system that positively involves health and safety culture. The BBS program may play an essential role in an organization's Environmental Health and Safety Management System. The BBS program alone cannot fix all safety issues, but it can be effective if applied carefully with other safety programs. Having a clear goal (problem), proper planning, consistent support, and reliable resources are required for a strong BBS program (Zigulis, 2015).

The current boom in the construction industry has been widespread in Malaysia. This incredible growth in the construction industry, especially from residential and commercial industries, has brought into Malaysia many inexperienced foreign construction workers with different levels of safety culture and contributed to its high rate of fatal accidents due to human error in construction industries in Malaysia, as reported by the Department of Occupational Safety and Health. This encouraged us to conduct the present study to examine the role of BBS in developing employees' safety perceptions and to decrease manpower errors and accident rates in the construction work environment (DOSH, 2020). To do so, this study focused on two types of construction companies (companies applying and not applying BBS) to examine the differences in employees' perceptions of organizational commitment, management commitment, safety communication, safety knowledge, transit workers, workers' mental states, safety training, and safety outcomes between companies practicing and not practicing BBS (Fig. 1). It was hypothesized that the implementation of BBS would influence the perception of the mentioned variables and improve behavioural safety in the construction industry.

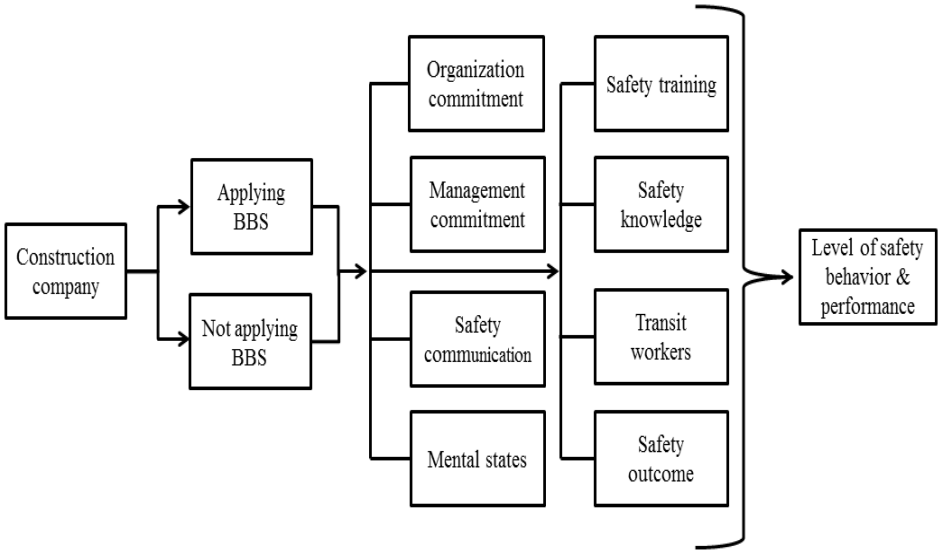

Figure 1 Study Research Model

Note: BBS, Behaviour-based safety

2.0 METHODS

2.1 Sampling

In total, 132 respondents from 13 construction sites scattered throughout Malaysia were surveyed. Online and indirect distribution questionnaires were used to collect the data. In online distribution, the questionnaire was developed through online survey tools, known as the Google Form, and sent to respondents via email. In indirect distribution (due to COVID-19 pandemic restrictions), safety supervisors and site supervisors helped researchers distribute and collect hard copies of the questionnaire. Employees included senior managers, managers, supervisors, and general workers. Although the current sample size was small because of the pandemic, we made an effort to cover all categories of employees. Management was first approached by the studied construction companies with the intention of proposing the present research project. Several online meetings (interviews) were conducted between the researchers and management of relevant companies, and a summary of the proposed research was presented. The management was approachable and responsive to the research proposal and agreed that the project would be beneficial. Unfortunately, because of the sudden COVID-19 pandemic, we were unable to access many sites as we had arranged earlier due to tight restrictions by authorities and companies (e.g., closing the site temporarily, not allowing a third party to enter the site, and reducing workers by up to 50%).

2.2 Research Instrument and Data Analysis

In this study, a rating scale questionnaire was used to measure the direction and intensity of employee safety behaviours and attitudes. The questionnaire included workplace safety variables related to BBS, such as organizational commitment, management commitment, safety communication, safety knowledge, transit workers, mental states, safety training, and safety outcomes. The questionnaire was rated on a five-point Likert scale ranging from strongly disagree (1) to strongly agree (5). The content of these instruments was taken and adapted from studies by Mearns et al. (1997), Carlson et al. (2000), Cox and Cheyne (2000), Vinodkumar and Bhasi (2009), Singh and Jain (2013), Amankwah et al. (2015), Wu et

al. (2018) and Lyu et al. (2018) to fit the research objectives. Pre-test and pilot studies were applied for face and content validity. Based on the pilot study, it took approximately 15 minutes for the respondents to respond.

Quantitative data analysis was performed using SPSS version 22 for descriptive and inferential statistics. One-way multivariate analysis of variance was conducted to examine the differences in organizational commitment, management commitment, safety communication, safety knowledge, transit workers, workers' mental states, safety training, and safety outcomes (culture) in the construction industries practicing and not practicing BBS. It was also used to examine the interaction between BBS and employees' perceptions of the aforementioned variables.

2.3 Reliability

Once the study instrument was generalized, it was ready for testing. The instrument content was evaluated by experts. The expert evaluation included individuals who could propose specific guidance on particular issues and who did not interact with potential survey respondents. Their assistance was in reviewing the items, making them appropriate, and matching the context of the study. The "experts" included two groups of people: external advisors, including a certified BBS trainer by Department of Occupational Safety and Health Malaysia and two senior lecturers on safety and management studies, and internal advisors, including three site safety managers/officers who had assisted the research group with this study. External language advisors went through the questions and narrowed down their interpretation of the meaning of the questions in the targeted language (Malay). We were very supportive of their criticisms and suggestions, and the study pre-test was completed once we were able to implement their advice.

Cronbach's alpha was used to analyze the internal consistency reliability coefficient of the instrument. An analysis was conducted to evaluate the reliability at the intended use level of the construction site. These alpha values ranged from 0.699 to 0.911, with an average of 0.827. The internal consistency reliability coefficients (Cronbach's alpha) were computed for all variables in this study. The results (Table 1) of the pilot study test show the reliability of the research variables and relevant items for each construct.

Table 1 Cronbach's Alpha Values for the Research Variables

Variable	Cronbach's Alpha (N=132)
Organization commitment	0.81
Management commitment	0.90
Safety communication	0.88
Safety knowledge	0.88
Transit workers	0.70
Mental states	0.69
Safety training	0.85
Safety outcomes	0.91

3.0 RESULTS AND DISCUSSION

The construction industry, because of decentralizing working tasks (job mobility), task variety, and workers rotated continually in different projects, is obviously one of the most hazardous work environments. In addition, short-term employment based on the project (job instability), payment per job, and system of employment are other factors that can impact a safe work environment. These parameters in the construction industry make it more challenging to monitor, train, and control workers to prevent accidents and ensure that their duties are performed safely (Fang et al., 2006). Psychological science defines perception as a cognitive process of inferential and constructive character, by which a subject can generate an interior representation of what happened in the exterior from information collected by the senses and information from memory (Solis-Carca and Franco-Poot, 2014). Therefore, improving individual safety attitudes can enhance the overall safety climate of the work environment.

BBS concentration refers to employees' actions (what they do), analysis of their actions (why they do it), and intervention towards action with research support to improve what employees do. This study investigated the importance of the BBS model on employees' perceptions of organizational commitment, management commitment, safety communication, safety knowledge, transit workers, workers' mental states, safety training, and safety outcome (culture) factors that could influence the sustainability of BBS in construction companies. Table 2 presents the respondents' occupations and their frequencies in the studied construction industries.

Table 2 Frequency and Percentage of Employees' Organizational Position (N=132)

Variable	Frequency	Percentage
Organizational Position		
Senior Manager	12	9.1
Manager	41	31.1
Supervisor	35	26.5
Clerk	3	2.3
General Worker	41	31.1

3.1 BBS and Study Research Variables

Behavioural safety shares a concern with human behaviour and safety performance with other approaches in the work environment. It is the approach of Behavioural studies on human performance towards safety problems in the work environment. This means that any safety programmer marking human performance as behavioural safety must follow the standard of systematic behaviour research as practices are implemented in the work environment (Basu, 2018).

This study's results indicate whether the BBS program helps the organization determine the relationship between employees' behavioural safety perception and other safety approaches to reduce unsafe actions in the construction work environment. It was hypothesized that the implementation of BBS would influence the perception of the study's latent variables. Table 3 presents the employees' perceptions of the study research variables with regard to companies applying and not applying BBS.

Table 3 Employees' Perceptions of the Study Research Variables with Regard to BBS Implementation

Variable	Yes (n=70)	No (n=62)	F	P-value
Organization Commitment	4.18±0.64	3.49±0.54	30.539	.000
Management Commitment	4.16±0.74	3.44±0.94	23.628	.000
Safety Communication	4.18±0.59	3.34±1.01	33.784	.000
Safety Knowledge	4.30±0.55	4.29±0.79	0.013	.910
Transit Workers	3.89±0.55	3.68±0.79	3.727	.056
Bad Mental States	2.88±0.83	3.32±0.54	10.457	.002
Safety Training	4.18±0.62	3.84±0.54	10.895	.001
Safety Outcome	4.33±0.55	3.66±0.79	31.987	.000

Note: Data are presented as mean±standard deviation. A level of 0.05 was considered statistically significant. BBS, behavioural-based safety.

The results showed significant mean differences between the scores of the research variables of different construction companies practicing and not practicing BBS, except for the safety knowledge variable (F=0.013, p=0.910). Companies applying BBS had better employee perception (higher mean) of the study research variables than those not applying BBS. A low response to bad mental conditions (mean=2.88, standard deviation [SD]=0.83) showed better

physiological safety in companies applying BBS than those not applying BBS (mean=3.32, SD=0.54). The safety outcome showed the second highest mean score (mean=4.33, SD=0.55) after the bad mental state variable that represented the reverse mean score. Although this study showed the lowest mean score for the transit (temporary) workers variable (mean=3.89, SD=0.55) among other variables in construction companies practicing BBS, employees' understanding of coping with temporary (outside) workers was slightly better than that of their colleagues in companies not practicing BBS (mean=3.68, SD=0.79).

Table 4 shows the percentage of employees' feedback on the study research variables in construction companies that applied and did not apply BBS based on the five-point Likert scale. Strongly disagree and disagree represent a low perception, whereas strongly agree and agree represent a high perception of employees, except for the bad mental state variable, which represents the opposite.

Table 4 Distribution of Respondents' Perception on Study Research Variables Based on BBS Implementation (N=132)

Variable	BBS	Total Percentage (%)				
		SD	D	N	A	SA
Organization Commitment	Yes	3.3	2.3	12.9	35.2	46.2
	No	10.2	4.1	35.2	27.3	23.2
Management Commitment	Yes	2.8	2.6	11.5	41.2	41.5
	No	2.5	21.6	23.9	32.6	19.4
Safety Communication	Yes	0.9	0.7	14.2	48.1	36.2
	No	15.3	10.4	22.0	27.9	17.9
Safety Knowledge	Yes	0.0	0.0	8.9	51.5	39.3
	No	0.5	1.1	12.4	40.4	45.5
Transit Workers	Yes	1.8	3.2	20.3	52.9	21.4
	No	1.6	6.4	32.7	40.3	18.9
Bad Mental States	Yes	10.0	27.6	30.9	27.1	4.3
	No	4.8	15.1	29.0	44.6	6.4
Safety Training	Yes	1.8	2.0	9.8	48.6	37.8
	No	0.2	6.2	25.1	45.6	22.8
Safety Outcome	Yes	0.0	1.2	12.4	38.6	47.8
	No	0.2	11.2	30.9	35.2	21.9

Note: SD: strongly disagree; D: disagree; N: neutral; A: agree; SA: strongly agree; SD and D represent a low perception, SA and A represent a high perception, except for the bad mental state variable, which represents the opposite.

The results indicated that employees' perceptions of companies applying BBS had a cumulatively higher and stronger percentage for each factor. Although early findings showed no significant difference in employees' understanding of safety knowledge in both types of studied construction companies, the results in Table 4 show employees' higher cumulative responses (agree and strongly agree=90.8%) on the understanding of the safety knowledge variable in companies implementing BBS. The distribution of respondents' perceptions of study research variables proved the efficiency of the BBS program for improving the behavioural safety of organizations and employees to reduce unsafe conditions and actions.

The results also indicated that the BBS program can lead to better organizational and management commitment in the construction industry. Companies practicing BBS clearly showed interest in the safety and health of their workers. These companies made higher responsibilities and better involvement of top management in employees' safety behaviour in comparison with companies not practicing BBS. The results also show that management (middle manager/supervisor) in companies practicing BBS ensured that everyone received the necessary information on safety, specifically safety behaviour, compared with their colleagues in companies not practicing BBS. Managers/supervisors look for causes, not guilty persons, when an accident occurs, and they try to treat employees involved in an accident fairly. It was also observed that there is no force by managers/supervisors on safe working behaviour in companies practicing BBS in comparison with companies that not practicing BBS. Managers try to apply positive reinforcement and encourage employees to engage in safe behaviours.

There is a strong relationship between BBS and commitment to management. Choudhry (2014) claimed that the correct implementation of goal setting (finding problems), feedback, and correct measurement of safety Behaviour by committed management can positively increase the level of safety performance at a construction site. The responsibility of the project management team is crucial for developing the BBS program. It is not easy for safety managers and supervisors to organize a BBS session without project management (top management) support. Safety specialists frequently admit that an organization's culture is the main determinant of its safety practices. The organization must be capable of systematically addressing how employees cooperate with each other to maximize the benefit of the new behavioural safety (McSween, 2003). BBS management tools can help organizations in this matter. To achieve an organization's BBS program, management must prove their commitment on a daily basis, and employees must believe that management is committed to safety. This process involves identifying employee concerns, ensuring that the workplace is designed and maintained appropriately, and creating a trusted and open environment.

Besides organizational and management commitment, safety communication and safety knowledge are other factors that may have the potential to improve employee's behavioural safety. Effective safety communication develops the sharing of related safety information that turns into desirable safety behaviours (Cigularov et al., 2010). The effective exchange of safety information between workers and workplaces will reduce injury rates (Alsamadani et al., 2013). Therefore, a BBS program can evaluate and improve employees' levels of safety communication and awareness. As mentioned earlier, the results in Table 3 show that the understanding of basic safety knowledge is almost the same for both types of construction industries, and there is no significant difference between companies that implement safety knowledge (mean=4.30, SD=0.55) and those that do not (mean=4.29, SD=0.79). This is because all construction companies must implement Occupational Safety and Health rules and regulations set by authorities in Malaysia. Therefore, workers of companies practicing and not practicing BBS were familiar with safety equipment, standard work procedures, and how to perform their tasks safely. They are aware of the hazards associated with their jobs, the required precautions to be taken, and how to personally sustain or develop workplace health and safety. Osman et al. (2015) claimed that the personnel's level of knowledge is higher than their practice level in major industries. They have a high understanding of behavioural factors but less practice with regard to their understanding.

We believe that being aware of workplace safety knowledge alone is insufficient to ensure a safe work environment. Knowledge without proper practice and sharing is impractical, and it is unable to change employees' behaviour alone. Proper communication with good training is needed to convert theoretical behavioural safety knowledge into practical and effective actions. In this regard, the results in Table 3 indicate better performance of safety communication in companies practicing the BBS program (mean=4.18, SD=0.59) than in those not implementing it (mean=3.34, SD=1.01). Thus, employees in companies practicing BBS believe in a better open discussion between workers and supervisors on their work problems. Workers were told when changes in work practices were suggested, and they were more inspired to look out for and support each other in addition to using each other's viewpoints and recommendations regarding safety. In fact, one of the most practical techniques for upgrading safety culture and preventing injuries is to improve safety-related communication throughout an organization (Williams, 2003).

In addition to the aforementioned variables, temporary workers' and employee' mental states are two other factors that are also claimed to affect the sustainability of behavioural safety in construction industries. Construction work is unclean, hard, and unsafe. It is also irregular, poorly paid, and definitely "unsuitable" (Lerche, 2011). These parameters may cause bad mental conditions for employees in the construction industry and affect their behavioural safety. We believe that having many outside workers (under different subcontractors) in a project threatens the safety level of the work environment. Workers with different safety backgrounds, cultures, understandings, in some cases, different languages, mentalities, adaptability, etc. will cause unsafe behaviour and action in the construction work environment. Therefore, the BBS program with effective training, observation, and intervention can help the organization ensure that workers' safety behaviour is at an acceptable level. Generally, temporary workers are new to the work environment and the organization's safety system; therefore, they are classified as a group of workers who are initially at risk. In fact, these newcomers must be trained to perform their work safely and to identify, understand, and avoid potential hazards to themselves and others (Dawson et al., 1988; Roughton and Mercurio, 2002).

As aforementioned, transit (temporary) workers frequently enter construction sites under different subcontractors and are an important factor that can directly influence site safety behaviour. Therefore, they should not be neglected by the company's safety department.

Lew et al. (2020) examined the safety performance of subcontractors in the Malaysian construction industry. Their results indicated a lower understanding and performance of subcontractors on what they should be aware of and improve in a construction project so that construction accident rates can be reduced and construction workers' safety is guaranteed. A lower understanding of using personal protective equipment, lack of worker training, lack of management commitment, and job experience are important issues that may cause lower behavioural safety and unsafe action of workers under subcontractors in construction industries. According to Hinze and Gambatase (2003), achieving effective and safe performance requires self-safety programs of sub-contractors that can complement the existing safety programs of the contractor. Contractors must improve the selection of subcontractors that have a specific combination of technical capabilities and safety practices. Therefore, to have a successful safety practice, good cooperation between the main contractor and the subcontractor is required. Hence, we believe that the BBS program as a behavioural safety management tool can tackle this duty by improving the behavioural safety of subcontractors' employees with regard to the safety program of the contractor of construction companies.

The results showed that employees' bad mental states also affect behavioural safety. Workers should be mentally mature to change their behaviour, and the BBS program can help them with this task. Employees in companies with BBS programs had lower responses to bad mental state conditions than those in companies without BBS programs. We believe that the authority in companies applying BBS is more sensitive to employees' working hours and that employees have attainable daily tasks with no overtime. Employees are also willing to take greater initiative for better safety behaviour in their work environment and always think about improving their safety experience.

The psychological condition of construction workers has a direct effect on their safety compliance and improves work involvement behaviour. However, increasing depression reduces workers' safety compliance and work involvement behaviour; thus, even safety motivation and knowledge will not be effective in these cases. Although the effects of the parameters that indicate the physiological conditions of construction workers are different, all were found to have a significant relationship with safety behaviour (Jung et al., 2020). Therefore, improving workers' psychological conditions via BBS can improve their safety behaviours.

In this study, safety training and safety outcomes were also claimed to be related to the BBS program. In fact, safety training is an important tool that increases workers' awareness of frequent risks related to the construction workplace by increasing their knowledge of hazard perception. Moreover, training inspires individuals to take safety-conscious decisions, restrict risk, and avoid possible accidents (Ojha et al., 2020). The BBS management tool can help employees in this manner. Safety behaviour explains the behaviour that supports safety practices and activities, such as providing safety training and safety compliance, and clarifies the main actions that are essential to employees based on the requirement of occupational safety and health to avoid accidents in the work environment (Mahmood, 2010). A good BBS program will expand employees' behavioural safety, and safety behaviour is an important factor for reducing workplace accidents and indirectly affecting the results of the event before injuries or accidents occur (Johnson, 2003).

As shown (Table 3), construction companies that apply BBS have better perceptions of employees' safety training and higher safety outcomes (mean=4.18, SD=0.62 and mean=4.33, SD=0.55, respectively) than companies that do not

apply BBS (mean=3.84, SD=0.54 and mean=3.66, SD=0.79, respectively). This means that safety issues are given high priority in site training programs, and safety training given to employees is adequate to empower them to evaluate hazards in the workplace, inspire others to apply safe practices and promote practicing safety among each other, encourage beginners to train effectively to learn safety rules and procedures, and involve employees in designing their own optimal safety learning processes.

According to Vredenburgh (2002), safety training can reduce accident rates. Thus, the aim of safety training is to enhance employees' operational skills, unsafe recognition ability, and safety awareness, with a focus on the importance of employees' attachment to production safety and their capability to work safely (Osman et al., 2015). According to the study results, BBS can affect employees' perceptions of safety training. Safety practices (training) alone cannot make employees perfect. Practice improves fluency; however, with no suitable feedback, repeating behaviour alone is unable to increase the level of safety. This is a great lead toward coaching and illustrates the main process of BBS observation and feedback. Through BBS, improving the capability of feedback is brought about in three basic ways: 1) peer-to-peer coaching discussions, 2) regular assessment of behavioural performance, and 3) examining the work team's level of safe or unsafe behaviour based on group data graphs and occasionally comparing the safety performance of one work team with another (Williams and Geller, 2000).

Moreover, the results showed that applying good BBS improves employees' participation in notifying management of important safety issues, improving their working confidential level, and giving them the best effort at work safety besides correcting their colleagues while they are working under risky circumstances, and personnel feel that monitoring safe or unsafe behaviours of colleagues and giving them appropriate feedback will develop safety levels. Therefore, the behavioural safety outcomes in companies applying BBS are higher than those not applying it. A BBS program can be used to identify any changes in the aim of the safety performance index, including safekeeping inspections (audit), evaluation of safety climate, and hazard identification and analysis, from a lagging indicator to a leading indicator (Flin et al., 2000; Grabowskiet al., 2007). Jasiulewicz-Kaczmarek et al. (2015) claimed that giving a certain degree of autonomy and control to workers on a daily basis activates giving them some sort of ability to be decisive and fix problems when critical risk factors are observed and recognized. A BBS program helps empower employees to enhance their overall performance, and the outcomes of this study showed the differences. The priority of solving human resource problems through effective behaviour change in human resource management is important for BBS. Hence, applying a BBS is important for achieving suitable performance and reducing incidents/accidents in the work environment.

Overall, an individual worker's safety behaviour is associated with different factors. However, the effects of these factors on safety behaviour differ because of the complicated relationship between these factors and individual safety behaviour. BBS management tools can help in this regard. At its core, BBS is a scientific approach to understand and alter human behaviour in the workplace to improve safety performance. We believe that improving each of these factors will improve the overall intervention for better BBS understanding and performance in the construction industry. Safety-related behaviour in a workplace typically begins as differently directed, which means that personnel comply with someone else's instructions. A policy statement, an operational manual, or a training program can be the source of such direction, and behaviour will automatically become a habit when certain behaviours are performed often and constantly for some time. Some habits are good and useful, whereas some are not, relying on their short or long consequences (Geller, 2005). Therefore, the BBS program's obligations are to observe, interfere, and convert undesirable habits (appearing as action) to desirable ones to improve workers' safety.

The following recommendations may further improve BBS at construction sites and will not be limited to the following:

a) Continually improve the organization's forms and reports to record the causes of construction accidents (better observation and feedback);

b) Organizations need to hire a sufficient number of experts for work-site inspection, factor evaluation, and BBS implementation;

c) Organization should have strict and straightforward rules and regulations on organizational health and safety, specifically behavioural safety in the work environment;

d) Management should promote and focus more on training and awareness regarding employees'

behavioural safety;

e) Individuals should be regularly involved in their behavioural safety decisions, safety interventions, and work safety-related feedback;

f) Close and regular observation of the entire process by middle management and foreperson is recommended;

g) Workers' operation time in addition to their attention to their welfare should be controlled inside and outside of their work environment; and

h) Practically, a no-blaming system increases positive reinforcement and reduces employee lack of engagement.

4.0 CONCLUSIONS

Although numerous studies have been conducted to reduce work-related accidents, significant actions that can fully protect individuals from engaging in risky situations still need to be considered. Among the most frequently used efforts in this regard is the good safety behaviour applied in an organization. With awareness of this important potential for avoiding work-related injuries and fatalities, companies have to develop methods to improve their safety programs, specifically their safety behaviour sessions. Nevertheless, organizations still face many problems in designing and building strong behavioural safety sessions to improve safety performance. Moreover, workers' diversity at construction sites causes different learning levels and styles that make safety behaviour more challenging and, as a result, negatively influences the safety knowledge obtained from that behaviour.

In conclusion, eight factors were identified to evaluate the success of a BBS program based on a thorough literature review and interviews with safety experts. The results indicated a stronger understanding and performance of research factors and safety behaviour in companies applying BBS in than in those not applying BBS. Overall, implementing BBS practices in the work environment facilitates a secure environment, promotes teamwork for monitoring and reducing the occurrence of hazardous events, and encourages employees to be active in planning safe work settings and observing colleagues' work habits that create a sense of continuity and loyalty.

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Original Article

Work Ability Index of the Older Workforce in Malaysia's Manufacturing Sector

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ABSTRACT: *Work ability is related to factors that may influence one's capacity to work. We determined the Work Ability Index (WAI) of the older workforce in Malaysia's manufacturing sector. A total of 390 respondents aged from 40 to 60 years old from the manufacturing sector. The Finnish Institute of Occupational Health (FIOH) self-administrative WAI questionnaire was used as the primary research tool. Data collection was performed using the questionnaire distributed via Google forms. We categorized 31.6%, 27.9%, 27.2%, and 13.3% of the respondents under good, excellent, moderate, and low WAI, respectively. Older workers in the manufacturing sector demonstrated good WAI scores, indicating that ageing did not affect their ability to perform work-related tasks entirely.*

Keywords- *Older Workforce, Manufacturing, Work Ability Level, Work Ability Index (WAI), Malaysia*

1.0 INTRODUCTION

The labour force of Malaysia consists of a population aged from 15 to 64 years who are either employed or unemployed (Department of Statistics Malaysia, 2018). According to data from Malaysian population projections, the demand for workers is increasing every year. Malaysia comprised an older population by 2020, when the percentage of people aged 65 years exceeded 7.2%. By 2035, Malaysia is expected to become an ageing nation, with 15% (5.6 million) of the population classified as older adults (DOSM, 2017).

The exact or commonly recognized age at which a person is considered an older worker is unclear. Several studies have focused on people who were older than 55 years, whereas other studies have examined those who were aged ≥45 years. In the United States, older workers may include people in their 50s and 60s. The definition of older workers has vexed the ageing workforce literature; this is because the concept varies considerably across contexts and cultures, with several factors for determining older adults (Perry *et al*., 1996).

1.1 Objectives

Our primary objectives were to determine the Work Ability Index (WAI) of older workers in Malaysia's manufacturing sector and to determine the sociodemographic characteristics that may affect the WAI.

1.2 Problem statement

1.2.1 Older Workers in Manufacturing Industries

Manufacturing is a heavy-duty sector that contributes to the highest number of workers in several countries. Johnson (2015) reported that older workers can also be found in small and medium enterprises, although this tendency could be attributed to their retention and ageing in small firms rather than to the recruitment of older workers. Older professionals and managers are the most likely occupational groups to report tiredness, stress, and long working hours (Smeaton *et al*., 2009).

Manufacturing also contributes to high-risk jobs depending on the tasks performed. For example, in a furniture manufacturing company, lifting heavy raw wood panels onto a cutting machine is a high-risk task performed repetitively by a single worker for four hours daily. High-demand or high-risk jobs could exceed the exposure safety levels or average human capabilities to meet such demands, leading to an increased risk of work-related health problems.

Manual workers report more physical problems with their work, whereas skilled craft and elementary workers report a lack of strength to perform their jobs, even when they are younger (Smeaton *et al*., 2009).

1.2.2 Work Ability

Bohle *et al.* (2010) reported that work ability was lower among people performing physical work than among those performing mental work. Further, work demands and work environment exerted the strongest influence on the work ability scores. Despite being a promising construct, work ability has limitations in terms of the definition, measurement, and prediction of some outcomes (Bohle *et al*., 2010). In addition, work ability decreases with age among those with high physical workload and low job control (Costa & Sartori, 2007).

The WAI has remained constant and high over the years among Italian workers in jobs with higher mental involvement and autonomy. However, it has significantly decreased with steeper trend for jobs with higher physical workloads and lower job control, e.g., among nurses and manual workers (Costa & Sartori, 2007). The WAI also differs based on the job field, and its level is lower in fields requiring more psycho-physical effort (Tobia, 2005). However, upon considering all job fields together, the work ability decreases with increasing age. Thus, the age can negatively influence perceptions of work ability, whereas good self-esteem and psychosocial well-being can positively influence the development of work ability (Tobia, 2005).

2.0 METHOD

2.1 Data Collection and Participants

Emails containing a Google Form link to the questionnaire were sent to employers registered with the Federation of Malaysian Manufacturers. Each employer was requested to distribute the link to employees aged between 40 and 60 years in 2021. All responses were submitted directly to the researcher's email account and were recorded in Microsoft Excel. Data were collected between March 2020 and November 2020.

2.2 Work Ability Index (WAI)

The Work Ability Index (WAI) was adopted from a questionnaire administered by the Finnish Institute of Occupational Health (FIOH). It was determined based on responses to a series of questions that considered the demands of work, worker's health status, and resources. WAI is a summary of seven items (Table 1).

Table 1 Items in The Work Ability Index

No.	Items	Range
1.	Current work ability, compared with lifetime best	0–10
2.	Work ability in relation to the demands of the job	2–10
3.	Number of current diseases diagnosed by a physician	1–7
4.	Estimated work impairment caused by diseases	1–6
5.	Sick leave during the past year (12 months)	1–5
6.	Own prognosis of work ability 2 years from now	1–7
7.	Mental resources	1–4

We collected and analyzed the results of the WAI questionnaire. Table 2 summarizes the classification system, with indications of the score ranges and the need for intervention.

Table 2 Classification of the Work Ability Index

Score Range	Classification	Intervention

7–27	Poor	Intervene to restore work ability
28–36	Moderate	Improve work ability
37–43	Good	Support work ability
44–49	Excellent	Maintain work ability

2.3 Statistical Analysis

Statistical analysis was conducted using the Statistical Package for Social Sciences (SPSS) software, version 23. Descriptive and cross-tabulated analyses were performed on the data.

3.0 RESULTS

3.1 Demographic Data among Older Workers in the Manufacturing Sector

A total of 390 respondents participated in this study. Table 3 summarizes their epidemiological characteristics. The respondents consisted of 262 men (67.4%), with 36% aged between 45 and 49 years. A total of 141 (36.8%) respondents worked as technicians/supervisors, with secondary school being the highest education level among 219 respondents (57.2%). The manufacturing sector in Malaysia can be categorized into seven types, and the highest number of responses was obtained from 89 respondents (23.2%) from the food, beverage, and tobacco manufacturing industries.

Table 3 Demographic Data of Older Workers in the Manufacturing Sector

Socio Demographic	Frequency (n)	Percentage (%)
Gender		
Male	258	67.4
Female	125	32.6
Age (Years)		
40–44	138	33.4
45–49	128	36.0
50–54	75	19.6
55–59	28	7.3
>60	14	3.7
Race		
Malay	265	69.2
Chinese	55	14.4
Indian	52	13.6
Others	11	2.9
Working experience (Years)		
≤5	58	15.1
6–10	91	23.8
11–15	43	11.2
15	190	49.6
Education level		
Never attended school	2	0.5
Primary	37	9.7
Secondary	219	57.2
Diploma/Certificate	87	22.7
Bachelor's	25	6.5
Master's	13	3.4
Working Position		

Senior Officer/Manager	30	7.8
Executive	68	17.8
Technician/Supervisor	141	36.8
Leader/Operator/Clerk	108	28.2
Other	31	8.1
Working Hours		
Normal	338	88.3
Shift	45	11.7
Body Mass Index (kg/m^2)(BMI)		
Underweight (<18.5)	11	2.9
Normal (18.5–24.9)	132	35.1
Overweight (25.9–29.9)	160	42.6
Obese (>30.0)	73	19.4
Type of Industries		
Electrical, electronic, and optical products	59	15.4
Transport equipment, other manufacturing, and repair	43	11.2
Non-metallic mineral products, basic metal, and fabricated metal products	71	18.4
Wood products, furniture, paper products, and printing	25	6.5
Food, beverages, and tobacco products	89	23.2
Petroleum, chemical, rubber, and plastic products	83	21.6
Textiles, wearable apparel, and leather products	13	3.4

3.2 Work Ability Index (WAI)

Table 4 summarizes the overall results for the WAI of older workers in Malaysia's manufacturing sector. We classified 124 (31.6%), 108 (27.9%), 104 (27.2%), and 51 (13.3%) respondents as having good, excellent, moderate, and poor WAI, respectively.

Table 4 WAI Among Older Workers in Malaysia's Manufacturing Sector

No.	Classification of WAI	Score Range	Frequency (n)	Percentage (%)

1.	Poor	7 to 27	51	13.3
2.	Moderate	28 to 36	104	27.2
3.	Good	37 to 43	121	31.6
4.	Excellent	44 to 49	107	27.9

Most respondents were classified under good and excellent WAI; nonetheless, we performed further analyses on those classified under poor and moderate WAI to identify their sociodemographic characteristics based on the type of industry they were currently employed in, the age, gender, and body mass index (BMI) (Figs. 5, 6, 7, and 8).

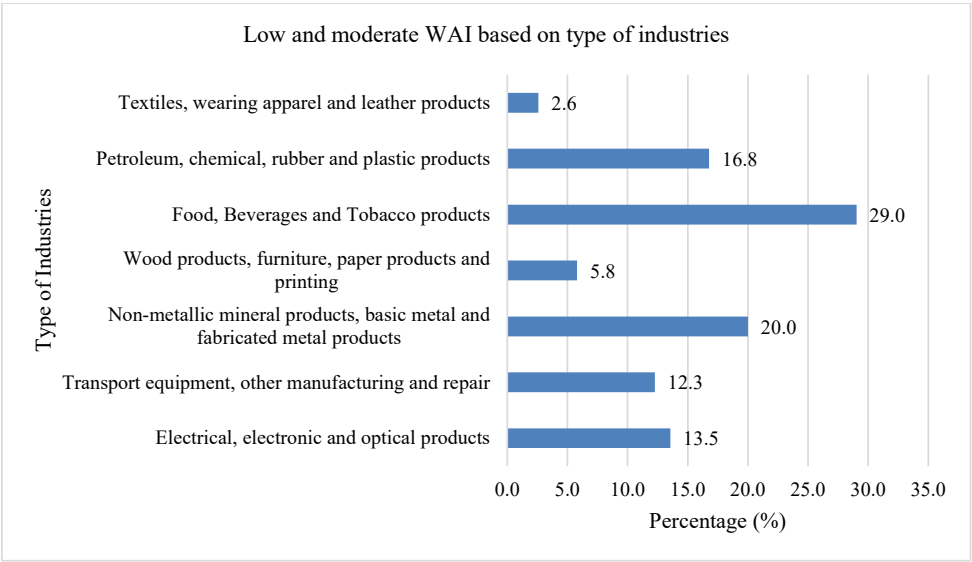

Figure 5 Distribution of Low and Moderate Work Ability Index Based On the Type of Industries

Fig. 5 depicts the low and moderate WAI distributions based on the industry type. The food, beverage, and tobacco product manufacturing industries consisted of the highest number of older workers (29%) classified under low and moderate WAI, followed by the nonmetallic mineral products, basic metals, and fabricated metal product manufacturing industries (20%).

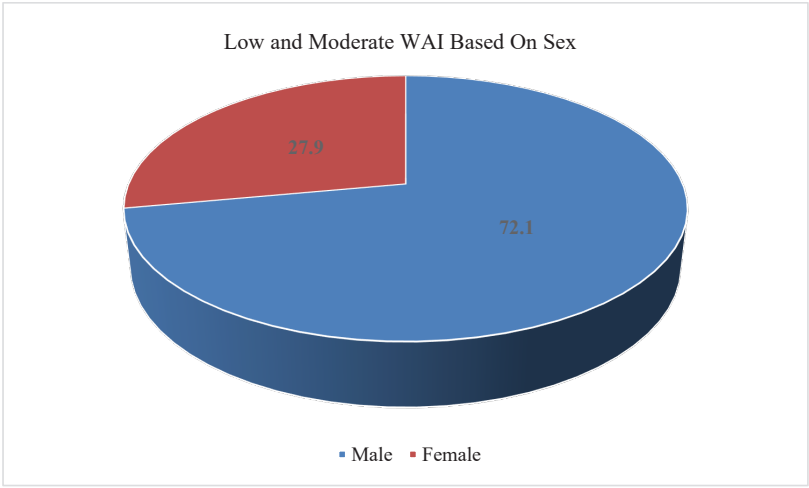

Figure 6 Distribution of Low and Moderate Work Ability Index Based On Gender

Fig. 6 depicts that 72.1% of the older workers with lower and moderate WAI were men.

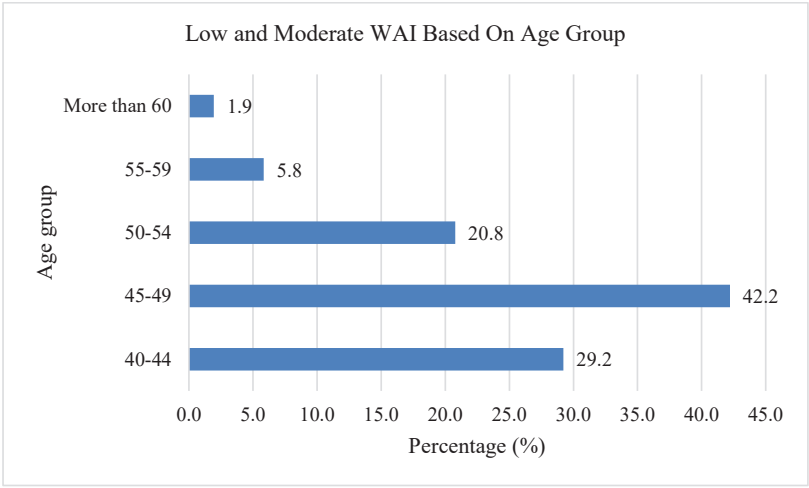

Figure 7 Distribution of Low and Moderate Work Ability Index Based On Age Group

Fig. 7 depicts that the highest percentage (42.2%) of the older workforce aged from 45 to 49 years was classified under low and moderate WAI, followed by those aged from 40 to 44 years (29.2%).

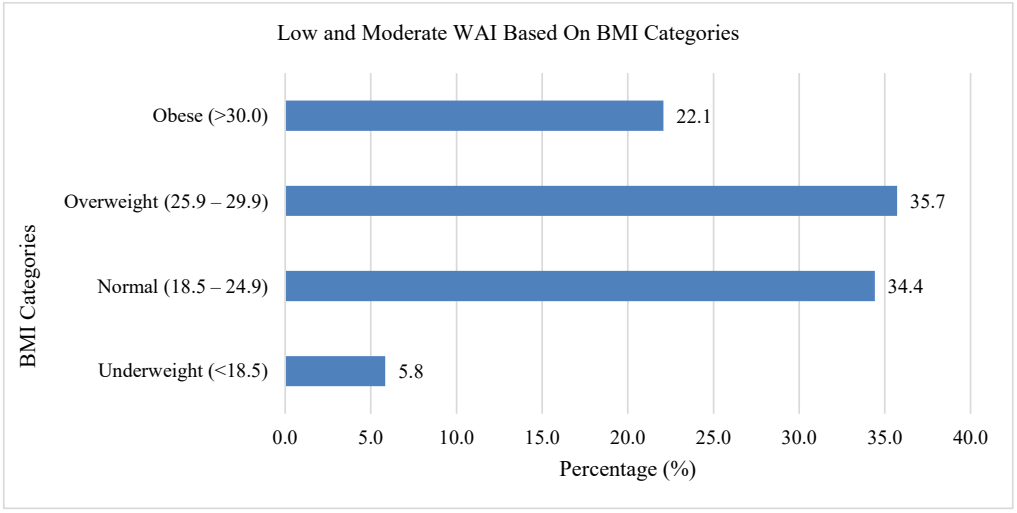

Figure 8 Distribution of Low and Moderate WAI Based on BMI Categories

Fig. 8 depicts the distribution of respondents with low and moderate WAI based on their BMI categories. A total of 139 respondents (35.7%) were categorized as overweight under low and moderate WAI.

4.0 DISCUSSION

We explored the level of work ability of older workers and their sociodemographic characteristics. Older workers in the manufacturing sector in Malaysia demonstrated mostly good WAI. Thus, ageing did not negatively affect the WAI. Further, those working in the food, beverage, and tobacco products industry, aged from 45 to 49 years, and overweight were mostly categorized under low and moderate WAI.

Thanapop (2021) reported that formal and informal workers in Thailand aged ≥55 years were at risk of poor to moderate WAI. Noncommunicable diseases (NCDs) were also negatively associated with the WAI and health status. Similarly, we demonstrated that the risk of poor to moderate WAI was more significant (42.2%) among those aged from 45 to 49 years, compared with those aged ≥55 years (7.7%). The age distribution could have affected these results; this is because 69.4% of the respondents were aged from 40 to 49 years.

Moreover, being overweight could increase the risk of poor and moderate WAI; 35.7% of the respondents were overweight and 22.1% were obese. Physical health is a determinant of an individual's lifestyle and can directly affect the health status and functional activity. A low level of physical health (e.g., a decline in physical capability and increased obesity) could negatively affect workers' ability owing to the increased risk of developing NCDs among older workers (Ilmarinen V. *et al.*, 2015). Similarly, Anderson (2017) demonstrated that BMIs above the reference range were progressively associated with lower work ability among older workers regarding a job's physical demands. Being overweight or obese can increase the risk of NCDs, thus negatively affecting the workers' physical capabilities.

5.0 CONCLUSION

The WAI among older workers in Malaysia's manufacturing sector was classified as good, indicating ageing did not affect their ability to perform tasks efficiently. However, demographic characteristics, the type of manufacturing industry, and BMI increased the risk of poor to moderate WAI.

ACKNOWLEDGEMENT

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Original Article

Literature Review of Emergency Cases Reported in Primary Schools

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ABSTRACT: *Emergencies could occur at any time and place. Thus, plans and procedures for emergencies must be established, especially in primary schools. This study intended to explore potential emergency cases in primary schools through a bibliometric analysis approach. Scopus database was used to collect all the literature on potential emergency cases that occurred at primary schools. Publish or Perish software was used to incorporate the obtained data, while VOS viewer was used for data visualization. The growth of publications, research productivity, and citation analysis were presented using standard bibliometric analysis. The search yielded a total of 535 articles from the Scopus database. The growth rate of potential emergency cases in primary schools have increased drastically every year from 2009 until 2020. Most of the articles were published in journals and mainly in English. The majority of the research on the risk of potential emergency cases in primary schools was in the medical field. Keywords including "human" and "primary school" were the most frequently used. Most of the research related to potential emergency cases in primary schools was conducted in the United States.*

Keywords - *Emergency Preparedness, Emergency Readiness, Potential Emergency, Primary School, Risk Management.*

1.0 INTRODUCTION

Schools are generally expected to anticipate and prepare to respond to a range of emergencies (Doyle, 2013). School management is obligated to ensure that students in their care are kept safe during and after emergencies as children are among the most vulnerable. Thus, the welfare of children at school has been the focus of global safety efforts in current times (Tipler et al., 2017). Emergencies are common in schools, and school authorities must establish plans and actions to respond to such serious events.

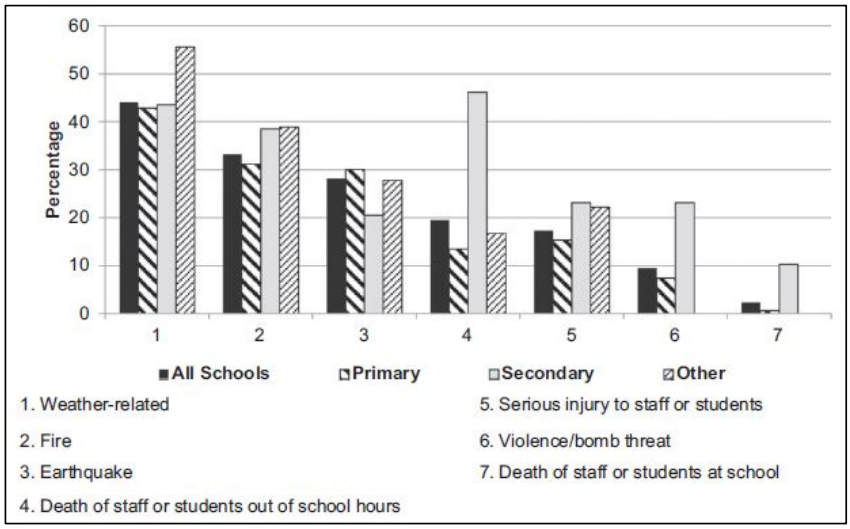

Figure 1 Types of emergencies children experienced in schools (2010–2012)

According to Tipler et al. (2017), almost 62% of schools in New Zealand had experienced at least one emergency event in the past three years, from 2010 to 2012. The emergencies were mostly weather-related events, fires, earthquakes, death of staff or students during and outside school hours, serious injury to staff or students, and violence or bomb threats. Among these emergencies, the three most common serious events were weather-related events (44%), fires (33%), and earthquakes (82%). A significant relationship was observed between school type and incidents involving the death of staff or students outside school hours, with secondary schools reporting higher frequencies of deaths. Moreover, higher percentages of violence or bomb threats (23%) are frequently reported in secondary schools than in primary (7%) and other schools (no cases reported). Emergency events caused 42% of schools to close temporarily (Tipler et al., 2017). Pediatric emergencies such as exacerbation of medical conditions, behavioral crises, and accidental or intentional injuries are expected to occur among schoolchildren, as they spend a significant proportion of their day at school (Robertson et al., 2004).

Research on the risk of potential emergency cases in primary schools began in 1963. Since then, researchers have widely used this term to further investigate the development of emergency preparedness and responses in the educational sector. Furthermore, global concern regarding the risk of potential emergency cases at primary schools has increased significantly, as indicated by the growing trends in scholarly work. Therefore, it is crucial to explore these publications before performing further research on this topic. Researchers should investigate the pattern related to the risk of potential emergency cases in primary schools to acquire insights and potential areas for future research.

This study aimed to analyze scientific literature published on the risk of potential emergency cases in primary schools using bibliometric analysis. Bibliometric analysis is a quantitative method used to examine the knowledge structure and development of research fields based on the analysis of related publications (IGI Global, 2018).

The first section after this introduction explains the purpose of conducting a bibliometric analysis, and the second section details the methodology adopted. The third section presents the results of the relevant bibliometric indicators. The last section summarizes and discusses the findings, identifies future research cases, and presents some limitations of this study.

2.0 LITERATURE REVIEW

2.1 Bibliometric Analysis

Bibliometric analysis is often used to evaluate scientific research through the quantitative study of research publications. Bibliometric analyses are based on the assumption that most scientific detections and research results are eventually published in international scientific journals where they can be read and cited by other researchers (Rehn et al., 2007). Therefore, bibliometric studies are typically used to estimate the quantity and quality of published articles to observe trends or patterns in a specific research area (Sweileh et al., 2017). Ahmi and Mohamad (2019) found that bibliometric analysis is gaining popularity as one of the methods to report research trends and effects. The most common indicators observed in bibliometric analysis include the classification of publications, citations, authorships, publication impacts, and countries of publications.

Bibliometric indicators can be categorized into three groups: quantity, quality, and structural indicators (Durieux & Gevenois, 2010). The quantity indicator states the productivity of a specific researcher, quality indicator refers to the performance of a researcher's findings, and structural indicator refers to the links between publications, authors, and areas of research. In case of disputes, we can conclude the progress, style, or productivity of the publication by analyzing the number of publications in a specific research area. The performance and impact of a publication can be evaluated through the number of citations or citations per year, total h- or g-index index, citation score, and other matrices.

Ahmi and Mohamad (2019) found that other studies have investigated the trend of publications through impact per publication and impact factor. In contrast, structural indicators or the engagement of published articles can be assessed using analyses such as co-authorship, co-citation, and bibliographic coupling. By using VOS viewer, for example, a few bibliometric methods such as co-authorship analysis, citation-based analysis, and co-word analysis can be performed.

2.2 Previous Bibliometric Analysis Studies

The number of bibliometric studies has increased over the years. Several studies have been conducted on the risk of potential emergency cases in primary schools. A summary of these studies, which have been conducted using bibliometric analysis and include the attributes examined, is presented in Table 1.

Table 1 Risk of potential emergency cases-related studies and their bibliometric attributes

Authors (Year)	Domain	Data Source & Scope	Bibliometric Attributes Examined
Pulsiri & Vatananan-Thesenvitz (2020)	Ambulance; Bibliometric analysis; COVID-19; drone; emergency medical services; Medical drone; Sustainable development goals; Systematic literature review	Scopus	Current research landscape and guidance for future research directions
Feng & Cui (2020)	Bibliometric analysis; Co-citation analysis; Emergency response; Social network analysis; Visual analysis	Scopus	Review of emergency response in disasters: present and future perspectives
Andersen et al. (2020)	Bibliometric; Coupling analyses; COVID-19; Keyword co-occurrence; Network graphs; Science mapping	Scopus	Emerging COVID-19 research: dynamic and regularly updated science maps and analyses
Jia et al. (2020)	Bibliometric; Cardiopulmonary Resuscitation; Emergency Service; Hospital	Scopus	Emerging trends and hot topics in cardiopulmonary resuscitation research: A bibliometric analysis from 2010 to 2019
Munawar et al. (2020)	Big data; Big data frameworks; Big data management; Big data storage; Data analytics; Disaster management; Disaster risk management; Machine learning; Property management; Smart real estate management	Scopus	Big data and its applications in smart real estate and the disaster management life cycle: A systematic analysis

All the studies used the Scopus database as their main data source to conduct the bibliometric analysis. To our knowledge, no other research (except those listed in Table 1) that employs extensive bibliometric analysis, especially those focusing on potential emergency cases, has been conducted until 2020.

3.0 METHODS

This study examined the risk of potential emergency cases in primary schools using bibliometric analysis. Some bibliometric indicators and network visualizations are demonstrated in this study.

Data were collected from the Scopus database on October 22, 2020. Scopus is the main existing single abstract and indexing database (Burnham, 2006) and the main searchable citation and abstract source for searching the literature (Chadegani et al., 2013). Some logical results were obtained from the retrieved documents, such as access type, year, author name, subject area, document type, source title, keywords, affiliation, country, source type, and language. For this study, we focused on all documents related to the following keywords: emergency, risk management, preparedness, readiness, and primary schools. All of these terms were selected based on the title of the document. The following query was conducted: Title ("emergency preparedness, emergency readiness, potential emergency, primary school, risk management"). This query yielded 535 documents for further analysis.

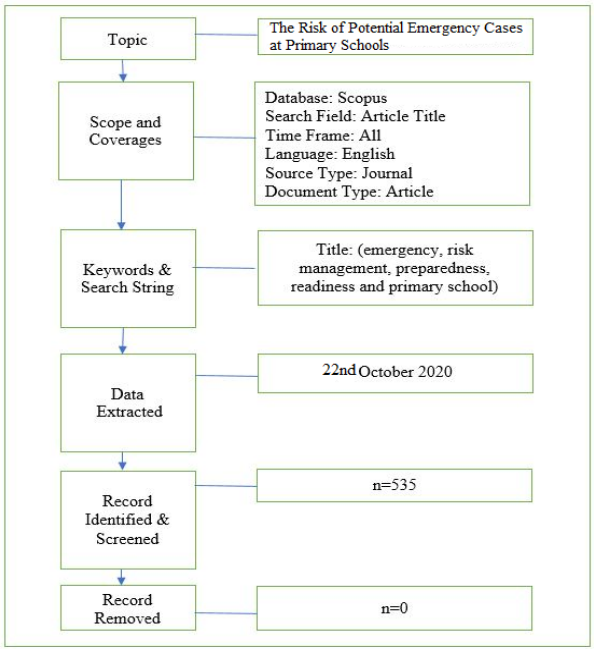

Figure 2 PRISMA flow diagram

The review adopted the Preferred Reporting Items for Systematic Reviews and Meta-Analyses for systematic reviews. The search strings "emergency preparedness" AND "emergency readiness" AND "potential emergency" AND "primary school" AND "risk management" were entered into the Scopus search engine. The initial search yielded 3,339 documents (Fig. 1). Additional documents, such as trade publications, short surveys, notes, reports, and errata, were excluded. After scanning the abstracts of all the documents in the list, further exclusions were made based on topical relevance. After Scopus subject filters were applied and the documents were screened, the final database included 535 documents on the risk of potential emergency cases in primary schools.

3.1 Sources and Data Collection

The Scopus database was used as the data source to achieve the objectives of this study. The database consisted of approximately 36,000 titles from almost 11,000 publishers with citation references mainly in peer-reviewed journals across subject fields including social, physical, health, and life sciences (Rusly, 2019). The search query including emergency, risk management, preparedness, readiness, and primary school was applied to the article titles within the Scopus database on October 22, 2020. This query yielded 535 documents for further analysis. The data were exported in CSV and RIS formats as part of the dataset. Software, such as Microsoft Excel, VOS viewer, and Harzing's Publish and Perish, were used to analyze the retrieved documents.

3.2 Result and Findings

Information extracted and analyzed from scholarly works comprised document and source types, annual growth, document's language, subject area, keyword analysis, country productivity, authorship, and citation analysis. Most

findings are presented as frequencies and percentages. Annual growth data was presented as the number of retrieved documents per year, including their frequency, percentage, and cumulative percentage, until September 2020. Finally, we reported citation analysis as citation metrics and disclosed the 20 most-cited articles with Web accessibility.

4.0 RESULTS AND DISCUSSION

4.1 Document and Source Types

The published documents from the datasets were analyzed based on their document and source types. Document type refers to the originality of the document, either a conference paper, an article, or a book chapter. In contrast, source type is the source of the document including journal, conference proceedings, book series, book, or trade publication. A conference paper categorized under the document type may differ from a conference paper categorized under source type (Sweileh et al., 2017). For example, a paper presented at a conference will be classified as a conference paper under the document type. However, the same paper might be classified as a full journal article, conference proceeding, or book chapter under the source type, depending on its publication status.

The analysis of extracted scholarly works included document and source types, language of the document, subject area, keyword analysis, country productivity, authorship, and citation analysis. Most findings until December 16, 2020 were presented as frequencies and percentages. Moreover, we disclosed the 20 most-cited articles with Web accessibility.

As presented in Table 2, all the articles were used as references. A total of 535 journal articles were retrieved, and all of the selected documents (100%) were considered as journals.

Table 2 Document and source type

Type	Total Publications (TP)	Percentage (%)
Document: Article	535	100
Source: Journal	535	100

As presented in Table 3, English was the most common language used in the gathered publications, representing 85.40% of the total documents. Some of the publications were published in Turkish, Spanish, Chinese, French, Italian, and Russian. One of the publications was published in a dual language.

Table 3 Languages used in published works

Language	Total Publications (TP)	Percentage (%)
English	468	85.40
Turkish	13	2.37
Spanish	12	2.19

Chinese	8	1.46
French	7	1.28
Italian	7	1.28
Russian	7	1.28
German	6	1.09
Serbian	6	1.09
Polish	3	0.55
Slovenian	3	0.55
Croatian	2	0.36
Portuguese	2	0.36
Bulgarian	1	0.18
Czech	1	0.18
Dutch	1	0.18
Lithuanian	1	0.18
Total	535	100

The categories of publications based on the subject area are summarized in Table 4. The scope of an emergency was one of the main focuses of studies in medicine and social sciences. Thus, both subject areas represented 52.9% and 42.8% of the total publications, respectively. Other significant subject areas included psychology, nursing, the arts, humanities, environmental science, and health.

Table 4 Subject areas

Subject Area	Total Publications (TP)*	Percentage (%)
Medicine	283	52.90
Social Sciences	229	42.80
Psychology	91	17.01
Nursing	32	5.98
Arts and Humanities	25	4.67
Environmental Science	20	3.74
Health Professions	17	3.18
Biochemistry, Genetics and Molecular Biology	14	2.62
Immunology and Microbiology	14	2.62
Neuroscience	12	2.24
Business, Management and Accounting	10	1.87
Agricultural and Biological Sciences	8	1.50
Engineering	8	1.50
Earth and Planetary Sciences	7	1.31
Computer Science	6	1.12
Multidisciplinary	6	1.12
Dentistry	5	0.93
Economics, Econometrics and Finance	5	0.93
Mathematics	4	0.75
Energy	3	0.56
Veterinary	2	0.37
Chemistry	1	0.19
Decision Sciences	1	0.19
Pharmacology, Toxicology and Pharmaceutics	1	0.19

Undefined	1	0.19

*The publications are classified based on the source title categorization. Some of the source titles aree classified in more than one subject area.

4.2 Research Trends

Bibliometric attributes were analyzed based on the publication year and annual growth, document and source types, language of the document, subject area, keyword analysis, country productivity, authorship, active institution, and citation analysis. Most findings are presented as frequencies and percentages. In addition, the co-occurrence of author keywords was mapped using VOS viewer, and citation analysis was reported as citation metrics. This analysis disclosed the top 10 most-cited articles on the risk of potential emergency cases in primary schools.

The first research on the risk of potential emergency cases in primary schools was published in 1963 by Fujinaga et al. (1963). They performed a developmental study on children's number concept based on the method of experimental education and discussed the necessary conditions for applying the method. Their research aimed to clarify the acquisition process of the number concept in children, which is initiated by internal factors such as maturation or readiness, using the "method of experimental education." They identified that external factors, such as learning, experience, and education, are equally important.

There are few publications related to the risk of potential emergency cases in primary schools. Additionally, until the term became popular in 1969, there were some years where no publication related to the risk of potential emergency cases in primary schools existed. Since then, the number of publications has increased significantly every year. Figure 2 illustrates the total number of citations, and the total number of publications with the highest citations was recorded in 2008 (TC=945). The most significant number of publications on the risk of potential emergency cases in primary schools was also recorded in 2018, with a total of 56 publications.

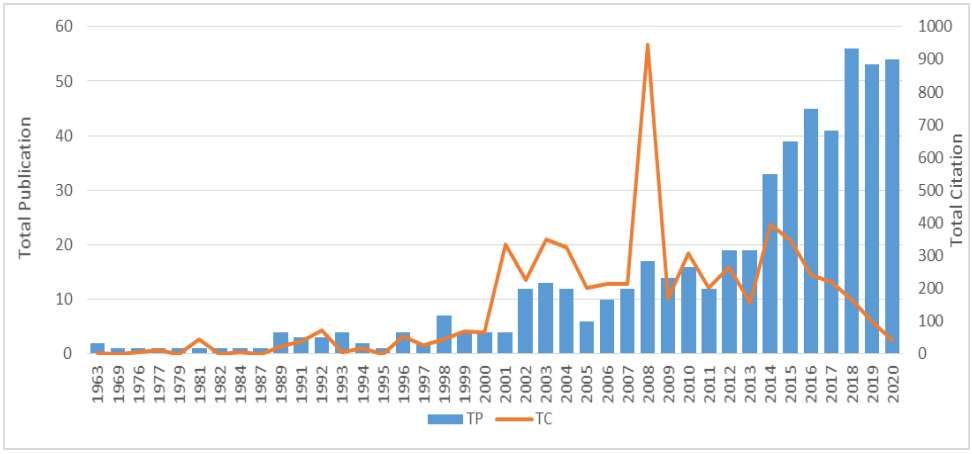

Figure 2 Total Publications and Citations by Year

Table 5 presents the total number of publications, percentages, and cumulative percentages of documents published on the risk of potential emergency cases in primary schools. It is expected that the number will continue to increase by the year 2020 as this topic is widely debated and gaining increasing attention, especially during the COVID-19 pandemic era.

Table 5 Total publications by year

Year	TP	Percent (%)	Cumulative Percent (%)	Year	TP	Percent (%)	Cumulative Percent (%)
1963	2	0.37	0.37	2002	12	2.24	11.96
1969	1	0.19	0.56	2003	13	2.43	14.39
1976	1	0.19	0.75	2004	12	2.24	16.64
1977	1	0.19	0.93	2005	6	1.12	17.76
1979	1	0.19	1.12	2006	10	1.87	19.63
1981	1	0.19	1.31	2007	12	2.24	21.87
1982	1	0.19	1.50	2008	17	3.18	25.05
1984	1	0.19	1.68	2009	14	2.62	27.66
1987	1	0.19	1.87	2010	16	2.99	30.65
1989	4	0.75	2.62	2011	12	2.24	32.90
1991	3	0.56	3.18	2012	19	3.55	36.45
1992	3	0.56	3.74	2013	19	3.55	40.00
1993	4	0.75	4.49	2014	33	6.17	46.17
1994	2	0.37	4.86	2015	39	7.29	53.46
1995	1	0.19	5.05	2016	45	8.41	61.87
1996	4	0.75	5.79	2017	41	7.66	69.53
1997	2	0.37	6.17	2018	56	10.47	80.00
1998	7	1.31	7.48	2019	53	9.91	89.91

1999	4	0.75	8.22	2020	54	10.09	100.00
2000	4	0.75	8.97				
2001	4	0.75	9.72	TOTAL	535	100.00	

*TP=Total publication

This study also evaluated the top 20 countries that contribute to publications based on the author's affiliated institution. Overall, 84 countries were identified. Table 6 shows the top 20 active countries that contributed a minimum of six publications in this study. The United States contributed the highest number of publications (95), representing 17.76% of the total publications on the types of emergencies, followed by the United Kingdom (10.28%), Turkey (9.72%), Australia (9.53%), China (3.74%), Russia (3.55%), and Italy (3.18%). This result reveals that developed countries are leading the research on the types of emergencies in primary schools.

The authors that published most articles on the risk of potential emergency cases in primary schools, with a minimum of three publications, are presented in Table 7. The top three most active authors in this field of research are from the United States with more than three publications each on the risk of potential emergency cases in primary schools.

Table 6 Top 20 countries that contribute to publications

Country	TP*	NCP*	TC*	C/P*	C/CP*	h*	g*
United States	95	17.76%	84	2510	26.42	29.88	**23**
United Kingdom	55	10.28%	46	825	15.00	17.93	**14**
Turkey	52	9.72%	29	146	2.81	5.03	**7**
Australia	51	9.53%	45	701	13.75	15.58	**13**
China	20	3.74%	13	70	3.50	5.38	**6**
Russian Federation	19	3.55%	5	14	0.74	2.80	**3**
Italy	17	3.18%	16	281	16.53	17.56	**9**
New Zealand	14	2.62%	13	160	11.43	12.31	**8**
Netherlands	12	2.24%	11	255	21.25	23.18	**5**
Germany	11	2.06%	10	39	3.55	3.90	**4**
Spain	11	2.06%	7	80	7.27	11.43	**4**
Canada	9	1.68%	7	61	6.78	8.71	**4**
Croatia	9	1.68%	5	17	1.89	3.40	**3**
Indonesia	9	1.68%	4	20	2.22	5.00	**3**
Japan	9	1.68%	7	45	5.00	6.43	**4**
Iran	8	1.50%	5	17	2.13	3.40	**2**
Malaysia	8	1.50%	3	20	2.50	6.67	**1**
Serbia	8	1.50%	7	20	2.50	2.86	**2**
Greece	7	1.31%	5	33	4.71	6.60	**3**
Belgium	6	1.12%	4	78	13.00	19.50	4

*TP, total number of publications; NCP, number of cited publications; TC, total citations; C/P, average citations per publication; C/CP, average citations per cited publication; h, h-index; g, g-index.

Table 7 Most productive authors

Author's	Affiliation	Country	TP*	NCP*	TC*	C/P*	C/CP*	h*	g*
Nix, R.L.	University of Wisconsin-Madison	United States	6	6	451	75.17	75.17	4	6
Bierman, K. L.	University Park	United States	5	5	444	88.80	88.80	4	5
Smith, G.T.	University of Kentucky	United States	4	4	183	45.75	45.75	4	4
Andrews, N.	Public Health England	United Kingdom	3	3	130	43.33	43.33	3	3
Donati, M.	Public Health England	United Kingdom	3	3	130	43.33	43.33	3	3
Elliot, A.J.	Public Health England	United Kingdom	3	3	130	43.33	43.33	3	3
Ellis, J.	Public Health England	United Kingdom	3	3	130	43.33	43.33	3	3
Heinrichs, B.S.	Pennsylvania State University	United States	3	3	59	19.67	19.67	3	3
Minematsu, K.	Kokuritsu Junkankibyo Senta	Japan	3	2	21	7.00	10.50	2	3
Pebody, R.G.	Public Health England	United Kingdom	3	3	130	43.33	43.33	3	3

*TP, total number of publications; NCP, number of cited publications; TC, total citations; C/P, average citations per publication; C/CP, average citations per cited publication; h, h-index; g, g-index.

4.3 Citation Analysis

Data gathered from the Scopus database were imported into Harzing's Publish or Perish software to generate the citation metric and total citations for each document based on Google Scholar citations. Table 8 summarizes the citation metrics for the retrieved documents published until October 22, 2020. This summary includes the total number of citations, citations per year, citations per paper, and citations per author.

Table 8 Citations metrics

Metrics	Data
Publication years	1963–2020
Citation years	57 (1963–2020)
Papers	535
Citations	5910
Years	57
Cites/Year	103.68
Cites/Paper	11.05
Cites/Author	1978.27
Papers/Author	225.68
Authors/Paper	3.67
h-index	37
g-index	64

The top cited articles in emergency preparedness are listed in Table 9. An article entitled “Preventing conduct problems and improving school readiness: Evaluation of the Incredible Years Teacher and Child Training Programs in high-risk schools” by Webster-Stratton et al. (2008) was the most cited (based on the Scopus database), with a total of 384 citations (32 citations per year).

Table 9 Most cited articles

Authors	Title	Year	Cites	Cites per Year
Webster-Stratton et al. (2008)	Preventing conduct problems and improving school readiness: Evaluation of the Incredible Years Teacher and Child Training Programs in high-risk schools	2008	384	32
Bierman et al. (2008)	Executive functions and school readiness intervention: Impact, moderation, and mediation in the Head Start REDI program	2008	383	31.92
Veltman et al. (2001)	Three decades of child maltreatment research: Implications for the school years	2001	148	7.79
Rigby & Johnson (2006)	Expressed readiness of Australian schoolchildren to act as bystanders in support of children who are being bullied	2006	147	10.5
Kelder et al. (2005)	The CATCH Kids Club: An after-school pilot study for improving elementary students' nutrition and physical activity	2005	138	9.2
Robertson et al. (2004)	Asthma prevalence in Melbourne schoolchildren: Have we reached the peak?	2004	130	8.13
Isbye et al. (2007)	Disseminating cardiopulmonary resuscitation training by distributing 35 000 personal manikins among school children	2007	76	5.85
Young & Ireson (2003)	Effectiveness of school-based telehealth care in urban and rural elementary schools	2003	68	4
Williams et al. (2008)	“Hip-Hop” stroke: A stroke educational program for elementary school children living in a high-risk community	2008	67	5.58
Webber et al. (2003)	The burden of asthma in inner-city elementary schoolchildren: Do school-based health centers make a difference?	2003	65	3.82
Pebody et al. (2014)	Uptake and impact of a new live attenuated influenza vaccine program in England: Early results of a pilot in primary school-age children, 2013/14 influenza season	2014	63	10.5
Bollig et al. (2009)	Primary school children are able to perform basic life-saving first-aid measures	2009	63	5.73
Olson et al. (2004)	School professionals” perceptions about the impact of chronic illness in the classroom	2004	63	3.94

4.4 Visualisation Map

The keywords used for this study were mapped with VOS viewer, a software tool for constructing and visualizing bibliometric networks. Fig. 3 presents a network visualization of the authors' keywords, and the color, square size, font size, and thickness of connecting lines are used to present relationships with other keywords (Sweileh et al., 2017). Keywords with the same color imply that they are commonly listed together (for example, primary schools, inclusive education, teachers, and training have the same color [blue], indicating that they are listed together in most publications).

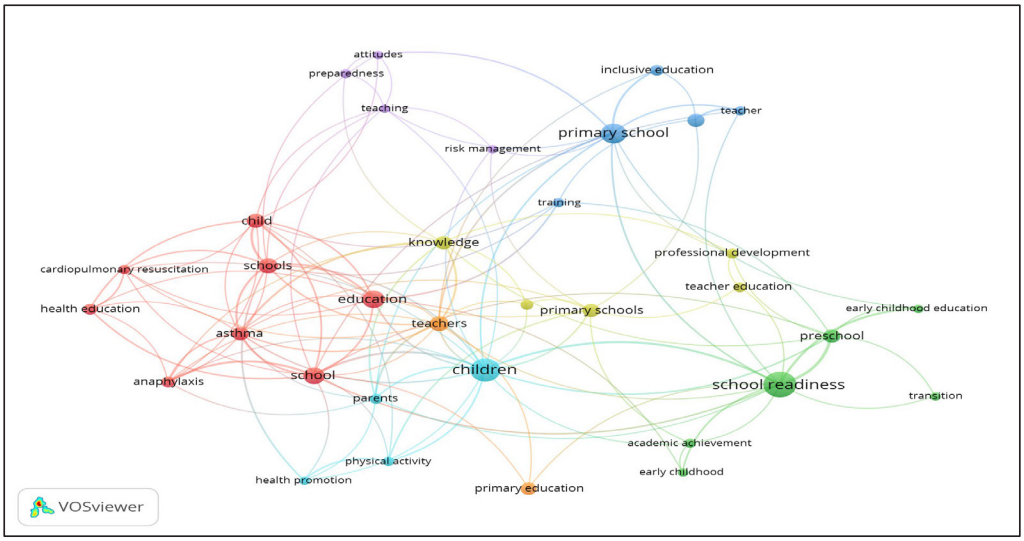

Figure 3 Network visualization map of keywords presented by authors

The published literature included the following three aspects: children, primary school, and school readiness. Fig. 3 suggests that schools, children, asthma, cardiopulmonary resuscitation, anaphylaxis, education, and health education, which are in red, are closely related and co-occur. Therefore, this red cluster is directly related to the other clusters in blue (keyword: children), orange (keyword: teachers), purple (keyword: preparedness), and light green (keyword: knowledge).

5.0 CONCLUSION

This bibliometric review provides clearer insights into the trends, historical reviews, forecasts, and contributions on the types of emergencies that occur in primary schools. Research on this topic began in 1963 and has subsequently been increasing annually. The number of publications drastically increased in 2018, with 56 publications identified compared with 41 in 2017. The total number of publications on the risk of potential emergency cases in primary schools is expected to increase by 2021. In contrast, the total number of publications reached 54 by 2020. Multiple authors have published articles related to the risk of potential emergency cases in primary schools.

The geographic dispersion of the literature shows that the United States, compared with other developed countries such as the United Kingdom and Japan, has the largest number of publications and influences in terms of the number of citations. Hence, more research on the risk of potential emergency cases in primary schools should be conducted in developing countries. Future research can be performed to explore the implementation of emergency preparedness and readiness in primary schools. Additional research can be expanded to the utilization and impact of technology, such as digital technology or any advanced technology, in emergency preparedness and readiness. In addition, policies for the development of emergency preparedness and readiness for primary schools should be reviewed in response to the COVID-19 pandemic.

5.1 Limitation

Our study has a few limitations that are inherent to the database used. Although Scopus is one of the largest databases, there are still unindexed journals; thus, publications in these journals may have been overlooked. Furthermore, this study focused on only the risk of potential emergency cases in primary schools based on the titles of the documents. Thus, all other studies related to the risk of potential emergency cases in primary schools with titles that do not explicitly include our study focus were excluded. It is also important to highlight that no search query was 100% perfect. False positive and false negative results may have been obtained. The citation analysis presented in our study was based solely on data from Scopus. The total number of publications and citations was only valid at the time of the search, which was October 2020. Despite these limitations, this study is among the first to analyze the detailed bibliometric indicators of published literature on the risk of potential emergency cases in primary schools.

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Original Article

Analysis of Machine-Related Occupational Accidents in the Malaysia Manufacturing Industry

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ABSTRACT: *Machine-related occupational accidents can put workers at risk of amputation, illness, disability, and even death. Therefore, in this paper, data related to machinery accidents in the manufacturing sector will be analyzed because this is the biggest sector in Malaysia's gross domestic product (GDP). To gather the data, annual reports filed by the Social Security Organization (SOCSO) from 2012 to 2018 and the Department of Occupational Safety and Health (DOSH) from 2015 to 2019 were used as the primary source of occupational accident records. Analysis of SOCSO reports showed that 80.1% of the accidents occurred in men. Among all sectors, the manufacturing sector recorded the highest percentages of accidents: 28.0% and 30.7% according to the SOCSO and DOSH, respectively. Furthermore, the SOCSO recorded the highest percentage of accidents, 34.1% of which were caused by metalworking machines. Surprisingly, the total percentages of women and men who experienced accidents in the manufacturing sector for all industries were 26.1% and 23.9%, respectively. Our findings are useful for policymakers to review policies and legislations of occupational safety and health to ensure employers provide a safe workplace for their workers because the magnitude of economic costs of work-related accidents and diseases are enormous, as indicated in the percentage of GDP. Future studies should address the factors that contribute to women in the manufacturing sector having a higher percentage ratio of accidents than men.*

Keywords : *Employers' Responsibilities, Manufacturing Industries, Metalworking Machines, Occupational Accidents, Workers Safety*

1.0 INTRODUCTION

In 2016, the World Health Organization reported that approximately 20–50% of nationwide workers are exposed to different workplace hazards. Furthermore, approximately 960,000 or more workers are injured, and 5,330 die of work-related disorders daily. The periodic research published by the International Labour Organization estimated that the economic costs of work-related accidents and diseases vary from 1.8% to 6% of the gross domestic product (GDP) (El-Menyar et al., 2016). Looking at the scale of our country, the Department of Occupational Safety and Health (DOSH) reported in 2017 that the Social Security Organization (SOCSO) spent RM2.7 billion for local workers and RM5.1 million for migrant workers on accident and disease costs. In that particular year there were 14.7 million workers, and 42,513 accidents occurred with 711 fatal cases, which means there were 2 fatalities per day (Md Noor, 2018).

Most manufacturing workplaces have heavy equipment and potentially harmful machinery. Many accidents occur due to machinery, as workers are involved in all stages of manufacturing, such as installation, operation, troubleshooting, maintenance, cleaning, and dismantling. Different machines contain various hazards that can cause injury and death. According to Chinniah (2015), machinery hazards include structural, physical, mechanical, slip/trip/fall, ergonomic, chemical, end-use conditions, and biological hazards. Said et al. (2012) stated that in the last three decades, industrial incidents in Malaysia have been increasing, and the manufacturing sector has recorded the highest number of injuries in all sectors. This indicates that workers in the manufacturing sector are subject to a higher risk of accidents than those in other sectors. Comparing the number of cases reported from 1998 to 2008, the number of fatal accidents in the local manufacturing sector increased from 256 to 268, while disability increased from 9,701 cases to 5,823 cases.

In Romania, manufacturing industries are registered as areas with the highest number of work-related accidents. Its manufacturing sector recorded an increase in accidents of 23% in 2017 compared to 2013. The increasing number of accidents in this sector is in line with the development of the Romanian industry, in which several multinational companies have entered the country's market (Ivascu and Cioca, 2019). According to Kogler et al. (2016), the number of fatalities reported in agricultural and forestry works in Austria is the second highest, but closer observation revealed that the types of accidents that were reported were machine-related. A total of 3,250 accidents related to machine categories were reported between 2008 and 2010. The classification of accidents by type of machinery showed that as high as 1,334 accidents were caused by timber processing machines, whereas as few as 46 cases were caused by crop production machines. Tremblay (2018) also pointed out that occupational accidents reported in the healthcare industry are machine-related.

The hospital sector uses various healthcare machines such as imaging devices, mechanical beds, and stretchers. Drill press and metal lathe machines are also used in maintenance services, and emergency generator and revolving shutter machines are used in physical installation services. These facilities employ a large percentage of non-medical workers in hospitals, which cover most machine-related accidents that can lead to various occupational injuries, diseases, and deaths.

The improper operation of a machine is extremely risky. It can be caused by unexpected movements of the machine, unpredictable starts or non-stop operation, spontaneous changes in speed, and ejection of machined pieces. The effectiveness in preventing occupational accidents can be improved when the employer provides information on the causes and conditions that lead to accidents at the workplace, as it greatly impacts the risk evaluation posed by incidents including methods of preventing them (Dźwiarek, 2015). Undeniable, poorly designed or defective machines can cause debilitating injuries to workers and lead to serious damage (Friedman, 2019). In most cases, flaws in the design or assembly of machines can pose a major safety danger to the workers. According to Dzwiarek and Latala (2016), manufacturers should decrease the risk of machine-related accidents by considering the issues of machine operation safety. Therefore, this paper aimed to analyze data on occupational accidents in Malaysian industries and categorize the data based on sector and sex. Additionally, it aimed to identify the causes, types, and location of the injury and the types of machines involved. A clear and in-depth understanding of machine-related accidents is highly important to strategize effective risk mitigation for a safe workplace. The manufacturing industry strongly influenced the country's economy, as it contributed to 23.6% of Malaysia's GDP in the fourth quarter of 2020 (Department of Statistics, 2021). The high rate of fatalities and accidents in the manufacturing industry has a magnitude of impact on the economy because it jeopardizes workers' well-being, increases downtime, decreases productivity, reduces workers' morale, and increases healthcare expenses.

2.0 LITERATURE REVIEW

According to the DOSH (2019), the number of occupational accidents in Malaysia's industry is still high, with a total of 40,811 cases in 5 years from 2015 to 2019. The pattern of accident and fatality rates also fluctuated between 2004 and 2019, which showed that the occupational safety and health management system in Malaysia's industry was still not fully enforced. Md Noor (2018) stated that the DOSH's objective is to prevent occupational diseases and industrial accidents by 2020 through efforts of reducing the fatality rate to 4.36/100,000 workers and the accident rate to 2.53/1000 workers, as well as increasing the reporting rate of occupational poisoning and diseases among workers by 30%. The department policy includes ensuring that all workers receive relevant information, instructions, guidance, and supervision on how to conduct tasks appropriately and in a quality manner that does not pose health risks. The fulfilment of customer requirements and legal and other specifications, as provided in the 1994 Occupational Safety and Health Act, its regulations, and the approved industrial practice standards are also being performed under the DOSH's policy (DOSH, 2020).

An infamous case involving a Bangladeshi worker at a glove factory, who lost his right hand after being caught in a rotating shaft, put the company under the spotlight of the DOSH and Labour Department. The company implemented 12-hour shifts and ran 24-hour production to meet the rising demands for medical gloves during the coronavirus disease pandemic. The Perak branch issued a stop-work order for any work activity on the production line and launched an investigation under the provisions of the Occupational Safety and Health Act 1994 and the Factories and Machinery Act 1967 after the case was reported by the Malaysian Trade Union Congress Pulau Pinang (FMT, 2020). The same company is also under continued probation from the DOSH following the deaths of three workers within 3 months because the employer failed to report these cases to the DOSH (Malaysiakini, 2021). The role of law is to protect workers from workplace accidents and evade workplace hazards via the enforcement of laws and regulations. Employers must therefore establish an effective occupational safety and health (OSH) management system. The Bangladeshi worker is an example of a machine-related accident that occurred because of poor OSH management systems that need to be immediately addressed by strict law enforcement to prevent any recurrence. The human resources department is responsible for planning and implementing methods in its organization. This is particularly critical in reducing the risk of civil and criminal penalties under the law, as well as in protecting the safety and well-being of workers (Ab. Aziz and Yusof, 2012).

Zakaria et al. (2012) conducted a correlation analysis between five independent variables, namely, stress and fatigue, unsafe acts, machinery and tools, design of the workplace, and training procedures, to explain their association with the dependent variable, i.e., workplace accidents in Malaysia. The output from the multiple regression analysis suggested that stress and fatigue and workplace design were the most contributing variables. Stress and fatigue in the norm of working life are synonymous for workers. To avoid these factors from becoming one of the contributing causes of workplace accidents, companies should design a proper work schedule that suits its work style. For example, workers who usually work at night should have sufficient rest during the day and be fit to continue their jobs at night. Furthermore, no workers should work too long after their usual schedule of working hours. Workplace design is a crucial part of avoiding accidents in the workplace. This study presents an example of machine-related accident risks that could be prevented using engineering control, such as an ergonomic design between high-risk and low-risk spots in the workplace, as well as a well-balanced working schedule.

3.0 METHODS

3.1 Process Flow

This study analyzed secondary data on occupational accidents obtained from a primary source accessed from the SOCSO website, i.e., the SOCSO annual reports from 2012 to 2018. Consent to use this primary data was provided by the Chief Executive of the SOCSO. Primary data were also gathered from the DOSH annual reports from 2015 to 2019, which are accessible from the DOSH website. Consent to use these primary data was provided by the Director General of the DOSH.

Figure 1 presents the flow of working with the textual data, which involved reading and segregating the data into categories, performing t-tests and analysis of variance (ANOVA) using Excel, and relating associations between categories. Subsequently, a synthesis of data was performed, which included exploring the pattern and relationship between accident factors and interpretation of the findings.

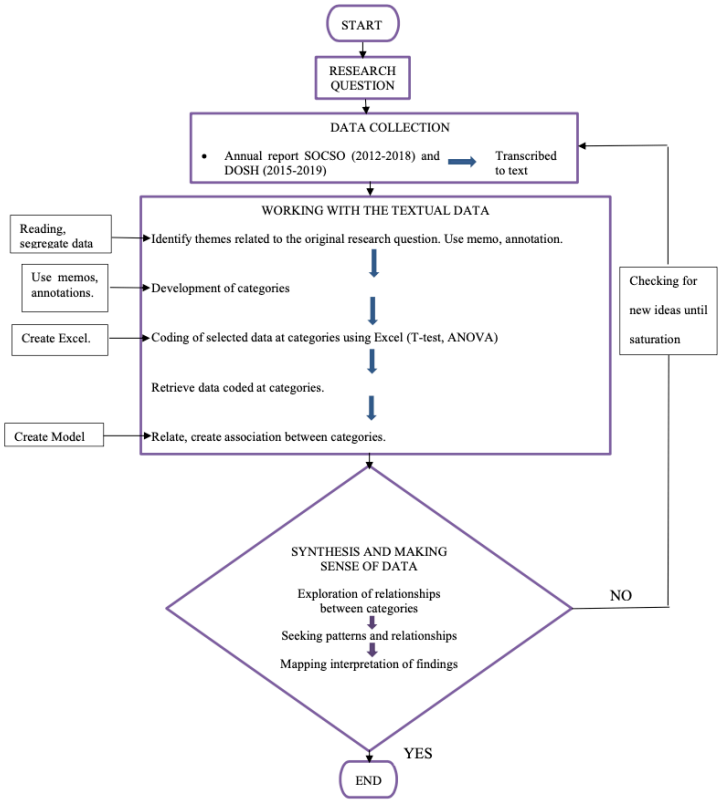

Figure 1 Flowchart of the Data Analysis

Note: SOCSO, Social Security Organization; DOSH, Department of Occupational Safety and Health; ANOVA, analysis of variance

3.2 T-Test

The t-test is a statistical test used to compare the means of two groups. It is frequently used in hypothesis testing to determine whether a method influences the population of interest or whether two groups differ from one another. It is also a parametric test of difference, which means that it uses the same data assumptions as the other parametric tests. The t-test presupposes that the data are independent and normally distributed, and that each group being compared has homogeneity of variance. When deciding to use a t-test, two factors must be considered: whether the groups being compared are from

the same population or two different populations and whether to test the difference in one direction or the other. The t-test was performed using the statistical analysis tool Excel (Microsoft Corp.). To assess the results immediately, the t-test function in the statistical software was used to calculate the t-value from the raw data and compare it to the critical value. The p-value was also calculated to assess whether the value was less than or greater than the significant value of 0.05. This information will help determine the null rejection, as the smaller the p-value, the higher the possibility of rejecting the null hypothesis (Bevans, 2020). In this study, the independent t-test was used to compare two different populations, and the one-tailed t-test was used to verify whether one population mean was greater or less than the other.

3.3 ANOVA

ANOVA is a statistical test used to examine differences between the means of more than two groups or several pairwise comparisons. There are two methods of ANOVA: one-way and two-way. One-way ANOVA is for one independent variable, whereas two-way ANOVA is for two independent variables. ANOVA identifies whether a dependent variable differs according to a group of independent variables. It also uses the F-test to compare multiple means simultaneously, as the error is determined for the entire set of comparisons rather than for each two-way (Bevans, 2021).

The null hypothesis (Ho) states that no differences exist between the groups. Conversely, the alternative hypothesis (Ha) states that at least one group differs significantly from the overall mean of the dependent variable. The Ho is rejected if any of the group means deviate considerably from the overall mean. This study used one-way ANOVA to analyze the Ho individually. Similar to the t-test method, ANOVA was performed using Excel. The most important element to determine whether the results are significantly different is the p-value. If the p-value is less than the alpha of 0.05, the method will reject the Ho and support the claim that the independent variables are unequal.

3.4 Development of the Hypotheses

The framework of the research considered sex as the theme of the t-test method, whereas for ANOVA, the independent variables were the sectors, causes of injury, type of injury, location of injury, and type of machine. The dependent variable was the number of accidents that occurred.

Ho and Ha Statement 1

Ho: The mean accidents reported for men would be greater than or equal to those reported for women.

Ha: The mean accidents reported for men would be less than those reported for women.

NO and HA Statement 2

Ho: The mean accidents reported for men would be less than or equal to those reported for women.

Ha: The mean accidents reported for men would be greater than those reported for women.

NO and HA Statement 3

Ho: All population means would be equal.

Ha: Not all group means would be equal.

4.0 RESULTS

4.1 Analysis of the SOCSO Data

Figure 2 shows that the accident statistics for men were significantly higher than those for women. To prove this statement, the t-test method was used because there were only two means for each group.

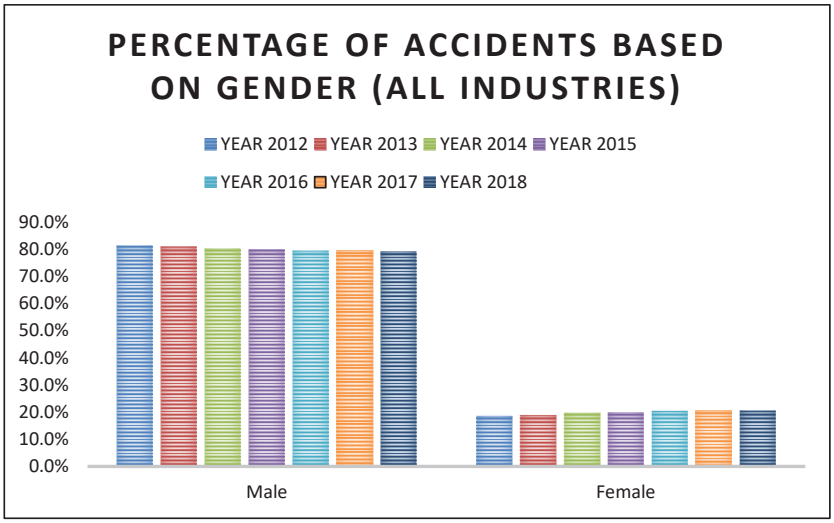

Figure 2 Percentage of Accidents by Sex for All Industries

Table 1 shows that the mean number of accidents reported by men was higher than that reported by women. Because the t-statistic (t-stat) value was positive, the complement (the area to the left of the t-stat) can be used in the left-tail test. Hence, the left-tail p-value was 1 − 3.962E-10 = 0.999, which is greater than 0.05. Figure 3 shows that the t-critical value of -1.86 and t-stat value of 32.91 do not fall in the rejection area. Therefore, the findings did not reject the first claim. Thus, the first NO that the average number of accidents for men would be significantly higher than that for women is supported by the evidence.

Table 1 T-Test Results: Two-Sample Assuming Unequal Variances for All Industries

	Men	Women
Mean	52,666.857	13,119.714
Variance	8,492,050.1	1,615,513.9
Observations	7	7
Hypothesized Mean Difference	0	
Df	8	
T-stat value	32.910985	
P-value (T≤t), one-tailed	3.962E-10	
T-critical value, one-tailed	1.859548	
P-value (T≤t), two-tailed	7.925E-10	
T-critical value, two-tailed	2.3060041	

Note: T-stat = t-statistic, t-crit = t-critical, p-value = probability value, Df = degree of freedom

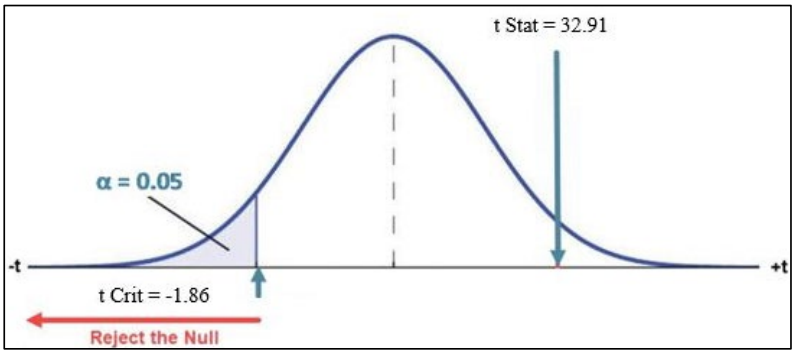

Figure 3 Left-tailed T-distribution of Accidents According to Sex

Note: T-stat = t-statistic, t-crit = t-critical

Narrowing it down to the manufacturing sector, Figures 4 shows that the male statistics are still higher than the female statistics throughout the study period. This statement can be confirmed using the t-test.

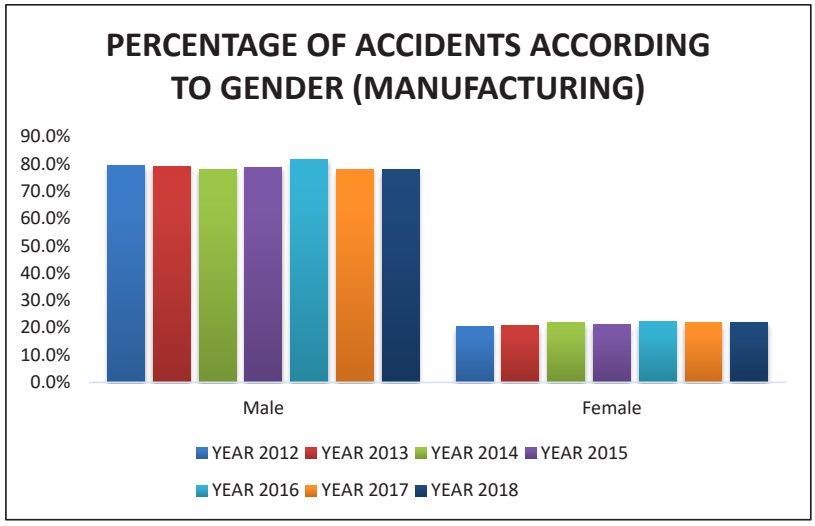

Figure 4 Percentage of Accidents Reported by Sex in the Manufacturing Sector

According to Table 2, the t-stat value was positive, which means that the one-tailed p-value can be applied using the right-tailed test. Because the p-value was 3.5692E-10, which is less than 0.05, and the t-stat of +44.867 was greater than the right-tailed critical value of +1.894, the second claim was rejected because the t-stat fell in the rejection area. Figure 5 supports the claim that the mean accidents reported by men were significantly higher than those reported by women in the manufacturing industry. It can be interpreted that the number of male workers was higher than that of female workers because more men are involved in the industry than women.

Table 2 T-Test Results: Two-Sample Assuming Unequal Variances for the Manufacturing Sector

	Men	Women
Mean	12,613.429	3247
Variance	267,716.952	25,736.33
Observations	7	7
Hypothesized Mean Difference	0	
Df	7	
T-stat	44.86691762	
P-value (T≤t), one-tailed	3.5692E-10	
T-critical value, one-tailed	1.894578605	
P-value (T≤t), two-tailed	7.13841E-10	
T-critical value, two-tailed	2.364624252	

Note: T-stat = t-statistic, t-crit = t-critical, Df = degree of freedom

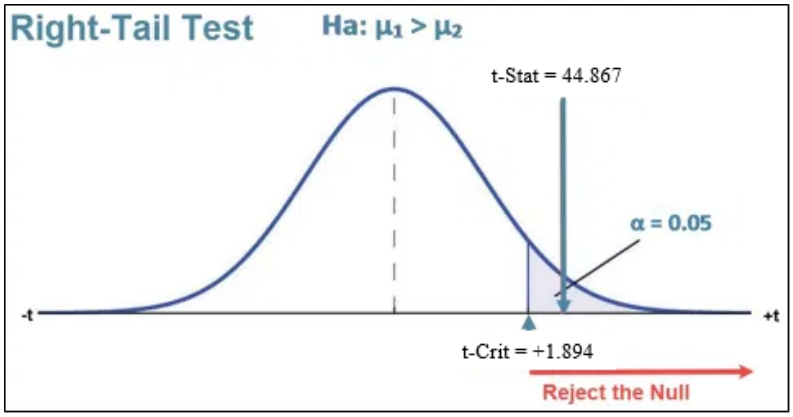

Figure 5 Right-tailed T-distribution of Accidents According to Sex

Although the number of accidents for men was higher in both categories, Table 3 reveals that the percentage ratio of accidents among women in the manufacturing sector for all industries was higher than that among men. This means that a larger fraction (23,989 of 91,838) of female workers experienced accidents than male workers, which only account for a small fraction (88,294 of 368,668) of the total male workers registered.

Table 3 Exposure to Risk of Hazards Based on the Percentage Ratio

Category	Sex	
	Male	Female
Manufacturing	88,294	23,989
All Industries	368,668	91,838
Percentage Ratio (%)	23.9%	26.1%

Next, we present the data analyzed using one-way ANOVA, where the independent variables were the sectors, causes of injury, type of injury, location of injury, and type of machine and the dependent variable was the number of accidents that occurred. Random samples of seven consecutive years were used to determine whether the mean number of accidents for each independent variable was significantly different.

The ANOVA results in Table 4 show that there were significant differences in the number of accidents occurring across different sectors, as the p-value is less than the significance level of 0.05. The same applies to the other variables, in which all recorded data indicate that there were significant differences in the number of accidents. Hence, the third claim was rejected, as the findings provide strong evidence that all independent variables including 10 sectors, 8 causes of injuries, 13 types of injuries, 8 locations of injuries, and 7 types of machines are not equal. To assess the individual differences between the groups and determine which groups were significantly different, post-hoc tests were performed. However, such a test is not suitable for independent data that have more than 3 variables because it is too crowded and impractical.

Table 4 One-way ANOVA According to the Independent Variables

Variable	Degree of Freedom	F-value	P-value
Between Sectors	6	229.21	5.099E-43
Causes of Injury	6	828.52	6.054E-42
Type of Injury	12	73.14	2.601E-37
Location of Injury	7	213.88	6.114E-34
Type of Machine	6	14.02	1.1E-08

Note: ANOVA = analysis of variance

Table 5 shows that the manufacturing sector had the highest number of reported accidents with a percentage of 28%, followed by wholesale and retail with 16.5% each. This indicates that 112,283 of 401,650 accidents occurred in the manufacturing sector from 2012 to 2018.

Table 5 Percentage Distribution According to Sectors

Sector	Total Accidents (%)
Agriculture, Forestry, and Fishing	14,585 (3.6)
Mining and Quarrying	2,752 (0.7)
Manufacturing	112,283 (28.0)
Electricity, Gas, Water, and Sanitary Services	5,953 (1.5)
Construction	47,987 (11.9)
Wholesale and Retail Trade	66,242 (16.5)
Accommodation and Food Services Activities	13,945 (3.5)
Transportation and Storage	27,093 (6.7)
Financial and Insurance/Takaful Services	48.318 (12.0)
Public Services and Statutory Bodies	62,492 (15.6)

Total	401,650 (100.0)

Table 6 highlights the most common causes of accidents that led to injury, including stepping on, striking against, or struck by an object (47.2%), followed by over-exertion or strenuous movement factor (13.1%). Overall, 153,438 of 325,191 accidents occurred between 2012 and 2018, which were caused by striking and struck incidents. These incidents could be caused by the failure of the machine to grip the specimen or by any loose components in the machine. Moreover, the over-exertion factor recorded 42,690 accidents that may occur because of lifting, pushing, carrying the bulk of raw materials, or relocating the machine, which requires considerable physical energy. All causes of injury that recorded a higher percentage were dominated by accidents in the manufacturing sector.

Table 6 Percentage Distribution of Accidents Based on the Causes of Injury

Cause	Total Accidents (%)
Struck by Falling Object	30,126 (9.3)
Stepping On, Striking Against, or Struck By an Object (Excluding a Falling Object)	153,438 (47.2)
Caught in Between Objects	28,735 (8.8)
Over-Exertion or Strenuous Movement	42,690 (13.1)
Exposed To/Contact with Extreme Temperature	3,017 (0.9)
Exposed To/Contact with an Electric Current	297 (0.1)
Exposed To/Contact with a Harmful Substance	1,024 (0.3)
Other Types of Accidents	65,864 (20.3)
Total	325,191 (100.0)

The types of injuries presented in Table 7 show that the highest number of injuries suffered by workers due to occupational accidents were sprains and strains (34.4%, 46,506/135,520 accidents). This injury type is correlated with the overexertion factor. Multiple injuries of different nature include injuries to more than one body system or area, and these were the second highest type of injury (20.2%, 27,343/135,520 accidents). This injury type can be related to the high number of accidents caused by striking or being struck by an object. The third highest type of injury was concussions and other internal injuries (19.2%, 26,301/135,520 accidents). It was correlated with accidents caused by stepping on an object, being struck by a falling object, and striking against an object, which resulted in internal injuries instead of external injuries.

Table 7 Percentage Distribution of Accidents Based on the Types of Injury

Types of Injury	Total Accidents (%)
Dislocations	11,438 (8.4)

Sprains and Strains	46,506 (34.3)
Concussions and Other Internal Injuries	26,031 (19.2)
Amputations and Enucleations	2,036 (1.5)
Superficial injuries	9,658 (7.1)
Contusions and Crushing	4,053 (3.0)
Burns	4,703 (3.5)
Acute Poisonings	278 (0.2)
Effects of Weather, Exposure, and Related Conditions	2,253 (1.7)
Asphyxia	725 (0.5)
Effects of Electric Currents	248 (0.2)
Effects of Radiation	248 (0.2)
Multiple Injuries of Different Natures	27,343 (20.2)
Total	135,520 (100.0)

Table 8 shows the location of injuries involving the upper limb of the human body (32.5%, 149,443/460,506 accidents) recorded from 2012 to 2018. This result is logical because workers use their upper extremities to perform most machine-related tasks. The percentage of workers who suffered upper limb injuries was high compared to that of other areas because the work process in machine-related conditions is primarily performed by hand. The head, neck, and trunk were the most exposed body parts during accidents caused by a falling object and being struck by an object, making these body parts the most vulnerable and the most in need of protection.

Table 8 Percentage Distribution of Accidents Based on the Locations of Injury

Location of Injury (Area)	Total Accidents (%)
Head	36,030 (7.8)
Neck	1,826 (0.4)
Trunk	53,272 (11.6)
Upper Limb	149,443 (32.5)
Lower Limb	108,279 (23.5)
Multiple Locations	71,484 (15.5)
General Injuries	15,017 (3.3)
Unspecified Location of Injury	25,155 (5.5)
Total	460,506 (100.0)

Table 9 shows that metalworking machines (34.1%) followed by agricultural machines (15.9%) had the highest percentage of accidents. This result shows that during the metal fabrication process, 6,894 accidents occurred over seven consecutive years from 2012 to 2018. The nature of the work may cause workers to be struck by materials or chips, burned from hot metals, and exposed to chemical metalworking fluids while performing their tasks. Additionally, agricultural machines had the third highest number of accidents (15.9%, 3,223/20,219 accidents). On the basis of the fact that the upper limb was mostly injured during occupational accidents, we deduced that agricultural machines such as grain augers, power take-off machines, and corn picker machines are the most frequent mechanical systems causing upper limb accidents.

Table 9 Percentage Distribution of Accidents Based on the Type of Machine

Type of Machine	Total Accidents (%)
Prime Movers, Except Electrical Motors	126 (0.6)
Transmission Machinery	720 (3.6)
Metalworking Machines	6,894 (34.1)
Wood and Assimilated Machines	2,922 (14.5)
Agricultural Machines	3,223 (15.9)
Mining Machinery	589 (2.9)
Other Machines Not Elsewhere Classified	5,745 (28.4)
Total	20,219 (100.0)

4.2 Analysis of the DOSH Data

Table 10 reveals that the number of accidents and fatalities in 2017 was higher than that in other years. Workplace accident rates per 1,000 workers increased to 2.93, up from 2.88 in 2016 and 2.81 in 2015. The total number of accidents was inversely proportional to the number of fatalities from 2015 to 2019. However, based on the number of workers registered each year, the accident rate per 1000 workers and fatality rate per 100,000 workers generally decreased. This decreasing trend resulted in the lowest fatality rates in five consecutive years from 2015 to 2019. The fatality rate per 1,000 workers was reduced to 3.83 in 2019. However, the number of occupational accidents was still high since the rate of accidents in the workplace increased by 13%. The increase was due to the increase in the average number of workers to 15.1 million from 14.8 million in the previous year.

Table 10 Occupational Accidents and Fatality Rate by Year

	2015	2016	2017	2018	2019
Accident Rate/1,000 Workers	2.81	2.88	2.93	2.4	2.71
Fatality Rate/1,000 Workers	4.84	4.70	4.90	4.14	3.83
Total Accidents	38,753	41,005	42,513	35,460	40,811
Total Fatalities	668	668	710	611	578
Average Number of Workers	13.8 million	14.2 million	14.5 million	14.8 million	15.1 million

Table 11 compares accidents between the sectors and shows that manufacturing recorded the highest number of occupational accidents, with 30.7% (61,006/197,542) of total accidents over a 5-year period from 2015 to 2019. This finding supports the analysis of the SOCSO data, where the result from the percentage distribution according to the sector pointed to the manufacturing sector as having a high distribution of accidents for seven consecutive years from 2012 to 2018. This indicates that the manufacturing sector in Malaysia is still lacking in terms of risk control and safety precautions, even though it is exposed to a high degree of hazard compared to other industries.

Table 11 Percentage Distribution of Accidents Based on Different Sectors

Sector	Total Accidents (%)
Manufacturing	61,006 (30.7)
Mining and Quarrying	1,154 (0.6)
Construction	21,214 (10.7)
Agriculture, Forestry, Logging, and Fishery	12,650 (6.4)
Utilities	3,042 (1.5)
Transport, Storage, and Communications	9,967 (5.0)
Wholesale and Retail Trade	24,114 (12.1)
Hotel and Restaurants	4,689 (2.4)
Finance, Insurance, Real Estate, and Business Services	13,747 (6.9)
Public Services and Statutory Bodies	46,959 (23.7)
Total	197,542 (100.0)

NO 3 stated that all mean groups would be equal, whereas the Ha stated that at least one mean group would be different. Table 12 shows that there were significant differences in the number of occupational accidents across the sectors. Since the p-value was 1.501E-31 and less than the significance level of 0.05, results of ANOVA rejected the NO but supported the claim that the mean of the 10 sectors was not equal.

Table 12 One-way ANOVA According to the Sectors

Source of Variation	Df	F	P-value
Between Groups	9	229.9975723	1.50147E-31
Within Groups	40		
Total	49		

Note: Df, degree of freedom

5.0 DISCUSSION

5.1 Sex

Using the independent t-test to compare two different populations and a one-tailed t-test to verify whether one population mean was greater or less than the other, the first claim was that the average number of accidents for men would be significantly higher than that for women. The left-tailed p-value was 1 − 3.962E-10 = 0.999, which was larger than 0.05. The t-critical value of -1.86 and t-stat value of 32.91 did not fall in the rejection area. Therefore, the findings did not reject the null hypothesis. The second claim was rejected because the t-stat value fell in the rejection area. However, the t-stat value was positive, which means that the one-tailed p-value could be applied using the right-tailed test. Because the p-value of 3.5692E-10 is less than 0.05 and the t-stat value of +44.867 is greater than the right-tailed critical value of +1.894, it can be concluded that the results reject the NO because there is sufficient evidence to support the claim that the mean accidents reported for men were significantly higher than those reported for women in the manufacturing industry.

Our study finding can be related to the increasing pattern in the number of active workers registered under the SOCSO from 2012 to 2018, with 7 million workers recorded in 2018, which was accompanied by economic growth over the period. According to IMF (2018), Malaysia's economy keeps on performing explicitly, with extended development of 5.3% in 2018. Male workers encounter more accidents than female workers because there is a larger population of men than women since industries tend to hire more male workers than female workers.

Although the male population recorded higher accident cases, a disturbingly higher percentage of female workers (26.1%) in the manufacturing industry encountered accidents in the workplace than their male counterparts (23.9%). The current workplace design may not consider the body anatomy and ergonomics of female workers, which exposes them to hazardous risks. For example, the manufacturing sector is a male-dominated industry, as its workplace design, arrangement of working layout, and placement of machines may only consider male physicality. The workplace should be ergonomically designed to fit the worker, not physically forcing the worker's body to fit the workplace. Taiwo et al. (2009) reported that female workers are at a higher risk than their male counterparts in heavy manufacturing environments because of their physical characteristics, age, and seniority. This finding may also address the requirement for competency in operating high-risk machines safely, as a previous study found that women are prone to injuries because less training is provided to them than to men (Abdalla et al., 2017).

5.2 Sector

Results of the one-way ANOVA are discussed based on the types of data obtained from the SOCSO annual reports. There were five independent variables: sectors, causes of injury, type of injury, location of injury, and type of machine. The dependent variable was the number of accidents that occurred. The findings rejected the third claim, as strong evidence indicated that the 10 sectors, 8 causes of injuries, 13 types of injuries, 8 locations of injuries, and 7 types of machine means were not equal. The results revealed significant differences in the number of occupational accidents across the sectors. Because the p-value is less than the significance level of 0.05, the data did not reject the NO and supported the claim that the mean of the 10 sectors is not equal. Therefore, it can be concluded that the data from both sources indicate that the manufacturing industry has a higher number of accidents than other sectors. Table 11 compares accidents between the sectors and shows that manufacturing recorded the highest number of occupational accidents from 2015 to 2019. This finding supports the analysis of the SOCSO data, where Table 5 displays the result from the percentage distribution according to the sector and pointed to the manufacturing sector as having a high distribution of accidents.

Ali et al. (2017) agreed that the manufacturing sector has high accidental hazards compared to other sectors, thus urging extensive research on occupational accidents, especially safety design. It is believed that accidents are related to how a machine is handled, the heavy material or equipment utilization, and non-compliance with the predefined rules and regulations (Dźwiarek, 2015). The importance of training and ensuring workers' acquired competencies is part of the recommended method to prevent accidents in the manufacturing sector, where the nature of the work is machine-related. It is the employers' responsibility to ensure that the machines have safety features and that all workers are aware of the emergency procedure when serious injuries occur. Previous studies have also supported the idea that training and competence are related to workers' education and skill development. Therefore, the selection of competent operators must be considered (Male, 2003 as cited in Zakaria et al., 2012).

5.3 Causes of Injury

Data from the SOCSO clearly showed that the most contributing factor to injury is stepping on, striking against, or being struck by an object. It was the cause of injury in 47.2% of total accidents that occurred from 2012 to 2018. According to Brownlee (2013), the top 10 most common injuries include strenuous movement, where someone pushes himself or herself beyond physical capacity. Other researchers have suggested that workers should be capable of identifying their capacity to perform assigned heavy work without harming themselves (Ali et al., 2017). Therefore, workers should be educated on occupational safety and health to protect themselves from harm and danger. A health literate worker will have informed knowledge to determine their ability to perform a heavy and hazardous task without pushing themselves to injuries. They will be motivated to implement a preventive culture in their workplace as they understand its importance for their health and safety benefits. Occupational health literacy specifically refers to how well workers obtain, communicate, process, and understand occupational health and safety information and services, and then use that information to make decisions about their health (Wong, 2012). Conversely, workers with low health literacy are at risk for more injuries, illnesses, and fatalities in the workplace (Parks et al., 2012).

5.4 Types of Injury

The most common types of injury caused by occupational accidents from 2012 to 2018 were sprains and strains. A sprain is the overstretching or tearing of ligaments that connect two bones in a joint. The most common location for a sprain is the ankle joint. Strain is the overstretching or tearing of tendons that connect bones to muscles. The hamstring muscle and lower back are the most common locations of muscle strain (Healthline, 2021). The second most common type of injury was multiple injuries. Delany and Berlin (n.d.) defined multiple injuries as multiple traumas, which is the presence of injury to more than one body system or area. Concussions and internal injuries accounted for 19.2% of accidents, and these injuries pose more harm than other injury types because internal wounds are unable to be seen with the naked eye and require radiography and even surgery (Felson, 2019).

The employer is responsible for assigning different tasks according to each worker's age, sex, and level of experience. This is because humans have dissimilar physical strengths, most notably between male and female workers. This concern is related to the workplace design, which considers the different sexes of the workers. When working in the industry, sprains and strain injuries are common. Health literacy is important for improving the health of individuals and populations. An adequately health-literate worker will be more alert to symptoms of sprains and strain injuries and seek medical attention because workers who understand their roles and responsibilities will be able to do their job better and contribute to the organization (IOM, 2004). To prevent sprain and strain injuries, employers could provide routine warm-up exercises and allow workers to take regular short breaks after sitting or standing too long to perform repetitive motions.

5.5 Location of Injury

The upper limb of workers was involved in the highest percentage of total accidents. Mucci et al. (2020) stated that the upper limb, especially the hand, sustained the most damage. This is because the work process is primarily handled using the hand compared to other body parts. In addition, upper limb injuries often occur from repetitive strain pain, occupational overuse syndrome, and cumulative trauma disorder that involve part of the arm from the fingers to the shoulder. Most industries that had the highest prevalence rates of upper limb injury were the manufacturing and construction industries, as they require handling heavy loads, moving parts, and repetitive tasks. Workers should be provided with high-quality personal protective equipment and trained to protect the upper limbs of their bodies. Consistently scheduled safety training produces result in work safety (Shannon et al., 1997 as cited in Zakaria et al., 2012). Machines with safety features, proper training, and personal protective equipment can prevent this type of injury. Besides, the machine must be calibrated and serviced according to the schedule, and workers should be encouraged to report near-miss incidents. Proper investigation and corrective action in near-miss cases can prevent accidents from occurring in the future.

5.6 Type of Machine

Metalworking machines caused the highest percentage of accidents. Generally, in the metal fabrication process, workers may be struck by material or chips, burned by hot metals, and exposed to chemical metalworking fluids while performing the task (CCOHS, 2018). The metal fabrication industry is dominated by small- and medium-sized enterprises, and various processes are involved, such as bending, welding, and assembly. Fabricated metal products are also used in offshore oil and gas industries, civil construction, and processing plants. The manufactured products include tanks, drums, metal boxes, tin cans, metal furniture and fixtures, wire and wire products, and household wares (MIDA, 2021). Metal fabrication holds an important place in Malaysia's manufacturing industry. One way to provide a safe workplace is by encouraging technological advances in Industrial Revolution 4.0 to incorporate unmanned technology, such as the automation of the Internet of Things (IoT). This strategy can reduce labor costs and prevent hazardous accidents across the various processes of milling, forming, welding, machining, stamping, and finishing because it minimizes the involvement of human workers in directly handling the machine.

6.0 CONCLUSIONS

This study presented an important finding: the SOCSO and DOSH data both showed that the manufacturing sector had the highest number of accidents. The percentage ratio of manufacturing in all industries from the SOCSO data showed that 26.1% of women are easily exposed to the risk of hazards. In total, 23,989 of 91,838 accidents involved female workers. This finding is useful for policymakers in formulating legislation and policies to enforce workplace designs that accommodate female anatomy and ergonomics, particularly in the Malaysian manufacturing industry. A conducive workplace will mitigate the risk of hazards and injury because the high-risk area has been properly identified, and preventive measures can be properly executed. The outcome of this study could facilitate policymakers in formulating policies that could decrease the pattern of high accidents among all workers in general and female workers to attain Sustainable Development Goals No. 8.8: Protect labor rights and promote a safe working environment.

The independent variables in this study, including the sector, causes, types of injury, location of injury, and type of machine, could be controlled to prevent the dependent variable, i.e., the number of accidents, from increasing. The proposed measure to control the independent variables is to engage workers in becoming health-literate. Proper training and scheduled safety programs can help workers become literate. A comprehensive understanding of workers' health literacy is the key to improving the outcomes of risk abatement and emergency preparedness. When workers are safe, productivity will increase, which will contribute to a higher industrial production index that could strengthen the country's economy. A high number of accidents involving metalworking machines can be controlled by the integration of automation and IoT elements to eliminate potential machine hazards. In the long run, this will reduce production costs, increase efficiency, and prevent accidents. Employers can be creative in instilling a working environment that always prioritizes safety. For example, employers can reward workers with remuneration when they can achieve zero accidents in their workplace. An incentive for becoming health literate will be a good approach to boost workers' morale. The outcome of this study can facilitate higher levels of economic productivity through technological upgrading to attain Sustainable

Development Goal No. 8.2: Diversify, innovate, and upgrade for economic productivity. This study also supports one of Maqasid Al-Sharia's objectives: covering the preservation of human life and well-being.

This study has a limitation in that it was unable to compare the data from the SOCSO and DOSH in a similar chronological order. Only data from 2015 to 2018 matched both primary sources, but the types of data still differed. There were also limitations in analyzing and comparing the data from both sources because of the difference in the types of data and inconsistency in providing constant information over consecutive years. Future work should address these shortcomings to provide a more comprehensive analysis of the accidents encountered by female workers in the manufacturing sector.

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Review Article

Tinjauan ke atas Peruntukan Perundangan bagi Perkhidmatan Doktor Kesihatan Pekerjaan di 5 Buah Negara

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ABSTRAK : *Tinjauan ini telah dijalankan untuk mengenal pasti peruntukan perundangan bagi perkhidmatan Doktor Kesihatan Pekerjaan (OHD) yang terdapat di negara-negara lain agar menjadi panduan bagi pembentukan perkhidmatan OHD di Malaysia. Lima negara (Perancis, Jepun, Belanda, Finland dan United Kingdom) telah dipilih berdasarkan pensampelan bertujuan. Akta berkaitan keselamatan dan kesihatan pekerjaan, dokumen agensi antarabangsa berserta artikel jurnal telah dirujuk. Hasil tinjauan mendapati sejarah penglibatan awal doktor di dalam aktiviti keselamatan dan kesihatan pekerjaan, perundangan berkaitan pekerja serta isu beban penyakit telah menjadi dasar peruntukan perundangan bagi perkhidmatan OHD yang sedia ada di sesebuah negara, maka terdapat perbezaan di dalam peruntukan perundangan bagi negara-negara yang dikaji. Terdapat negara yang memperuntukkan taraf kelayakan OHD perlu mempunyai kepakaran serta menetapkan nisbah pekerja kepada OHD yang diperlukan. Untuk tanggungjawab, peranan dan fungsi OHD pula, terdapat negara yang lebih menekankan perkara ini dengan memperincikannya dengan jelas di dalam perundangan mereka. Penekanan dan perincian ini adalah seiring dengan taraf kelayakan, hak dalam menjalankan tugas serta hak perlindungan OHD di dalam sesebuah negara tersebut. Kesimpulannya, peruntukan perundangan bagi perkhidmatan OHD di sesebuah negara adalah dipengaruhi oleh pelbagai faktor di dalam negara tersebut dan penekanan perundangan bagi tanggungjawab dan hak OHD perlulah seimbang dengan satu sama lain.*

Kata kunci - *Doktor Kesihatan Pekerjaan, Perkhidmatan Kesihatan Pekerjaan, Peruntukan Perundangan.*

ABSTRACT : *This review was done to identify the legislative provisions for Occupational Health Doctor (OHD) services in other countries to guide Malaysia's development of OHD services. Purposive sampling was used, and five countries were selected. Five countries (France, Japan, Netherlands, Finland, and the United Kingdom) were purposively sampled. The countries' occupational safety and health laws, international agency documents, and journal articles were reviewed. This review found the history of an earlier involvement of doctors in occupational safety and health activities, legislations involving workers, and disease burden issues charted the current legislative provisions for OHD services in a country, hence the differences in the legislative provisions among the studied countries. Some countries stipulate the qualification of OHD must be at a specialist level and have set the required worker to OHD ratios. As for the OHD's responsibilities, roles, and functions, there are countries that emphasize this by specifying it in their legislation. These emphasis and details are in tandem with the country's level of qualification, duty rights, and OHD protection. In conclusion, legal provisions for OHD services in a country are influenced by various factors, and the legislative emphasis on the responsibilities and rights of OHD should be balanced with each other.*

Keywords **-** *Legal Provisions, Occupational Health Physician, Occupational Health Services.*

1.0 PENDAHULUAN

Doktor Kesihatan Pekerjaan di Malaysia telah diiktiraf di dalam perundangan Malaysia pada tahun 2000 dengan termaktubnya Peraturan Keselamatan dan Kesihatan Pekerjaan (Penggunaan dan Standard Pendedahan Bahan Kimia Berbahaya Kepada Kesihatan) 2000. Di bawah Peraturan ini dan seterusnya Peraturan-peraturan lain yang berkaitan, aktiviti survelans perubatan bagi pekerja hanya boleh dilakukan oleh mereka. Doktor Kesihatan Pekerjaan juga lebih dikenali sebagai Occupational Health Doctor atau secara ringkasnya, OHD. OHD merupakan pengamal perubatan berdaftar di bawah Akta Perubatan 1971 yang mempunyai sijil amalan tahunan dan berdaftar dengan Ketua Pengarah Jabatan Keselamatan dan Kesihatan Pekerjaan (JKKP). Syarat-syarat bagi pendaftaran OHD dengan JKKP adalah memiliki sekurang-kurangnya diploma pascasiswazah kesihatan pekerjaan yang diiktiraf oleh Kerajaan Malaysia dan Ketua Pengarah JKKP atau telah berjaya menamatkan latihan kursus kesihatan pekerjaan yang diluluskan oleh Ketua Pengarah JKKP dan lulus peperiksaan Doktor Kesihatan Pekerjaan yang dikendalikan oleh National Institute of Occupational Safety and Health (NIOSH).

Selain daripada berperanan di dalam survelan perubatan, OHD adalah diharapkan untuk membuat diagnosis dan melaporkan penyakit pekerjaan dalam kalangan pekerja di Malaysia. Walaupun dari segi perundangan, semua doktor perubatan di Malaysia perlu memainkan peranan ini, namun pendedahan OHD secara langsung kepada pekerja-pekerja di industri menyebabkan mereka lebih cenderung untuk bertemu dengan penyakit-penyakit pekerjaan dan selanjutnya membuat diagnosis dengan betul dan melaporkannya kepada JKKP. Mendiagnosis dan melaporkan penyakit pekerjaan merupakan salah satu syarat pembaharuan pendaftaran OHD yang perlu dibuat setiap 3 tahun.

Selain daripada kedua-dua peranan ini, OHD juga terlibat di dalam memberikan perkhidmatan lain yang tidak termaktub di dalam perundangan seperti memberi promosi kesihatan di tempat kerja. Perkhidmatan ini kebiasaannya diberi di atas permintaan industri itu sendiri. Bagaimanapun, belum terdapat sebarang panduan yang jelas dan komprehensif kepada majikan dan industri mengenai perkhidmatan yang boleh diberikan oleh OHD.

Peranan dan fungsi OHD boleh dikenal pasti dengan melihat kepada perkhidmatan kesihatan pekerjaan (OHS) yang digariskan oleh pihak berwajib di peringkat antarabangsa seperti Organisasi Buruh Antarabangsa (ILO). ILO telah menggariskan peranan dan fungsi OHS melalui *ILO Occupational Health Services Convention 1985* (No. 161) dan *ILO Occupational Health Services Recommendation* 1985 (No. 171). Bagaimanapun, pelaksanaan OHS berserta adaptasi peranan dan fungsi OHD di negara-negara lain, terutamanya negara yang menjadi pelopor dari segi OHS, perlu dilihat jika peranan dan fungsi OHD hendak digariskan di Malaysia. Pun begitu, peranan dan fungsi OHD di negara lain perlu dikaji berdasarkan sistem penjagaan kesihatan negara tersebut, sejarah penubuhan OHS itu sendiri serta keperluan perundangan yang dikenakan ke atas OHS dan OHD itu sendiri. Perkara-perkara ini perlu dikaji bersama peranan dan fungsi OHD bagi mendapat gambaran yang jelas mengenai perkhidmatan OHD di negara tersebut. Oleh itu, tinjauan literatur ini dijalankan bagi mengenal pasti peruntukan perundangan bagi perkhidmatan OHD di negara-negara lain agar panduan perkhidmatan OHD di Malaysia yang berasas dan sesuai dapat dibentuk.

2.0 KAEDAH

Kerangka metodologi adalah dibentuk bagi mengenal pasti, menilai, mensintesis dan membandingkan sumber utama maklumat bagi menjawab perkara-perkara berikut:

I. Apakah sejarah penglibatan doktor/OHD di dalam perkhidmatan keselamatan dan kesihatan pekerjaan untuk negara yang dipilih?

II. Apakah peruntukan asas berkaitan OHD di bawah perundangan untuk negara yang dipilih?

III. Apakah perkhidmatan OHD di bawah perundangan berkaitan perkhidmatan kesihatan pekerjaan untuk negara yang dipilih?

Bagi tujuan tinjauan ini, negara-negara adalah dipilih dengan menggunakan pensampelan bertujuan. Negara-negara dipilih dari kedua-dua model sistem penjagaan kesihatan iaitu model Beveridge dan model Bismarck. Model sistem penjagaan kesihatan harus diambil kira untuk mendapat pemahaman yang komprehensif mengenai sistem perkhidmatan kesihatan pekerjaan (Jain et al., 2021). Kedua-dua model ini dipilih kerana ia mirip dengan sistem-sistem penjagaan kesihatan yang melibatkan pekerja-pekerja di Malaysia. Model Bismarck menggunakan sistem insurans tanpa keuntungan yang ditanggung bersama oleh majikan dan pekerja melalui potongan gaji manakala model Beveridge melibatkan sistem penjagaan kesihatan yang dibiayai oleh kerajaan melalui pembayaran cukai (Wallace L.S., 2013). Negara Perancis, Belanda dan Jepun dipilih untuk mewakili model Bismarck dan Finland serta United Kingdom telah dipilih bagi mewakili model Beveridge. Negara-negara ini dipilih berdasarkan kepada penekanan di dalam perkhidmatan kesihatan pekerjaan itu sendiri agar tinjauan ini menjadi lebih holistik. Negara Perancis dipilih berdasarkan perkhidmatan kesihatan pekerjaannya yang berteraskan kepada perubatan pekerjaan manakala Belanda pula di atas perkhidmatan yang lebih berfokuskan rehabilitasi dan keupayaan kerja. Finland pula dipilih kerana perkhidmatannya berteraskan perkhidmatan kesihatan primer. United Kingdom pula merupakan negara di mana sistem perundangan serta kesihatannya sering didasari oleh sistem yang ada di Malaysia dan Jepun pula dipilih bagi mewakili negara Asia.

Sumber utama yang digunakan di dalam tinjauan literatur ini adalah merangkumi akta berkaitan keselamatan dan kesihatan pekerjaan dan perkhidmatan kesihatan pekerjaan bagi negara-negara tersebut. Bagi negara yang tidak menggunakan bahasa Inggeris atau Perancis di dalam dokumen mereka, versi dokumen dalam bahasa yang digunakan oleh agensi perundangan negara tersebut akan dirujuk. Rujukan kepada dokumen yang dikeluarkan oleh ILO dan Pertubuhan Kesihatan Sedunia juga dilakukan bagi mendapat maklumat yang komprehensif. Artikel akademik berkaitan perkhidmatan OHD juga dibuat mengikut kesesuaian maklumat yang diperlukan.

3.0 KEPUTUSAN

Setiap negara mempunyai akta berkaitan kesihatan pekerjaan yang menerangkan peruntukan perkhidmatan kesihatan pekerjaan (OHS) bagi pekerja (Jadual 3.1). Bagi setiap akta ini, peruntukan perkhidmatan doktor telah disebut secara langsung atau tidak langsung. Doktor yang terlibat di dalam bidang kesihatan pekerjaan secara amnya dikenali di seluruh dunia sebagai occupational health physician/ doctor (OHP/OHD). Mereka merupakan salah satu kategori profesional di dalam perkhidmatan kesihatan pekerjaan yang diiktiraf di peringkat global. Di dalam kertas tinjauan ini, terminologi OHD akan digunakan bagi mewakili dan merujuk kepada mereka serta untuk menyeragamkan istilah.

3.1 Sejarah Penglibatan OHD di Dalam Sistem Perkhidmatan Kesihatan Pekerjaan

Di kebanyakan negara, sejarah penglibatan doktor di dalam perkhidmatan kesihatan pekerjaan biasanya bermula dengan penubuhan perkhidmatan kesihatan pekerjaan itu sendiri. Doktor diperlukan bagi memberi perkhidmatan klinikal serta mengenal pasti dan merawat pekerja dengan penyakit pekerjaan. Di Perancis, umpamanya, perkhidmatan kesihatan pekerjaan tercetus sejak abad ke-19 di atas gerakan kemanusiaan untuk memastikan pampasan bagi kecederaan pekerjaan diberi dan pekerjaan diiktiraf sebagai salah satu risiko kesihatan (Matsuda S., 2012). Oleh itu, doktor telah ditugaskan untuk melakukan pemeriksaan perubatan bagi mengenal pasti penyakit pekerjaan di kalangan pekerja di industri-industri utama dan klinik ditubuhkan di beberapa kilang sebagai faedah sampingan kepada pekerja. Peranan doktor kemudiannya telah ditambah di dalam Akta Buruh 1919 dengan berakhirnya Perang Dunia Pertama. Pada ketika itu, doktor diperlukan oleh majikan untuk menjalankan pemeriksaan perubatan bagi memastikan pekerja berada dalam tahap kesihatan yang sesuai untuk bekerja dan mengesahkan penyakit yang dialami telah berlaku sebelum pendedahan di tempat kerja. Semenjak dari itu, pindaan demi pindaan terhadap perundangan berkaitan peranan OHD telah dilakukan mengikut keperluan. Bagaimanapun, perkara yang masih kekal unik di dalam perkhidmatan OHD di Perancis adalah peperiksaan kesihatan mandatori kepada semua pekerja yang perlu dijalankan setiap 2 tahun (Paillereau G., 2005).

Di Jepun pula, polisi yang mewajibkan doktor untuk menjaga kesihatan pekerja-pekerja telah bermula dengan perubahan yang dilakukan ke atas Perundangan Kilang (Factory Law) pada tahun 1938 (Mori K, 2018). Di bawah perundangan ini, majikan perlu mengambil perkhidmatan seorang doktor jika kilang mereka mempunyai bilangan pekerja 500 orang atau lebih. Sewaktu itu, doktor-doktor ini dikenali sebagai Doktor Kilang. Kebanyakan mereka merupakan doktor di perkhidmatan primer yang menjalankan perubatan keluarga. Mereka ditugaskan untuk merawat kecederaan dan mencegah penyakit berjangkit dalam kalangan pekerja kilang tersebut. Mereka juga dikehendaki melakukan rondaan tempat kerja secara bulan dan menjaga aspek-aspek kebersihan di tempat kerja. Pada tahun 1947, Akta Piawaian Buruh telah menukarkan kriteria tempat kerja yang wajib mempunyai perkhidmatan Doktor Kilang dari 500 orang pekerja kepada sekurang-kurangnya 50 orang. Bagi mengurangkan beban kerja doktor-doktor ini, mereka digalakkan untuk bekerjasama dengan pihak lain untuk aktiviti higen industri. Istilah OHD bagaimanapun telah digunakan sejak tahun 1972 dengan terbentuknya akta baru iaitu Akta Keselamatan dan Kesihatan Industri di mana mereka dikehendaki menjalankan semua aktiviti yang telah termaktub sebelum ini dan ditambah dengan aktiviti-aktiviti pengurusan kesihatan pekerjaan yang lain.

Di negara Belanda pula, perkhidmatan kesihatan pekerjaannya bermula sekitar waktu yang sama dengan Perancis iaitu di abad ke-19 setelah seorang doktor dilantik sebagai inspektor kesihatan bagi Inspektorat Buruh negara tersebut (Hulshof & Frings-dresen, 2010). Pada waktu tersebut, doktor-doktor juga telah dilantik di syarikat-syarikat besar untuk memberikan perkhidmatan pencegahan dan rawatan kepada penyakit-penyakit pekerjaan dan penyakit berjangkit. Pada tahun 1962, dengan tertubuhnya Akta Perkhidmatan Kesihatan Pekerjaan, perkhidmatan OHD menjadi wajib bagi tempat kerja yang mempunyai pekerja melebihi 750 orang (tidak termasuk pekerja pejabat) dan juga bagi industri yang berisiko seperti industri yang menggunakan logam berat. Pada tahun 1984, dengan pengenalan Akta Kondisi Pekerjaan (Work Conditions Act), OHD yang bertauliah sebagai pakar perubatan telah diperkenalkan sebagai satu dari empat penggerak utama perkhidmatan kesihatan pekerjaan multidisiplinari. Penggerak utama yang lain adalah jurutera keselamatan, ahli higen industri dan penasihat organisasi. Bagaimanapun, pada tahun 1994, satu lagi reformasi untuk Akta ini telah diluluskan bagi memenuhi keperluan yang timbul akibat dari perubahan kepada peruntukan Akta Insurans Disabiliti yang menswastakan sebahagian dari sistem insurans sosial serta meletakkan tanggungjawab kepada majikan bagi memikul bebanan kewangan berkaitan kes-kes ketidakhadiran bekerja akibat sakit dan disabiliti pekerjaan dalam kalangan pekerja. Oleh yang demikian, semenjak itu, fokus perkhidmatan OHD di Belanda telah banyak beralih kepada aktiviti berkaitan rehabilitasi kerja iaitu pencegahan ketidakhadiran bekerja akibat sakit dan aktiviti *return-to-work* bagi pekerja yang mempunyai disabiliti. Banyak kajian yang dilakukan pasca perubahan ini menunjukkan bahawa peranan OHD di Belanda hanya berfokuskan kepada aktiviti *return-to-work* dan sokongan terhadap OHD untuk melakukan aktiviti pencegahan seperti survelan perubatan adalah sangat kurang (Los et al. 2019). Bagaimanapun, pindaan terakhir kepada Akta ini pada tahun 2017 telah meningkatkan semula peranan OHD di dalam perubatan pencegahan dengan memberi akses bebas di tempat kerja kepada OHD.

Di Finland pula, susulan perundangan kesihatan dan keselamatan pekerjaan yang pertama termaktub pada 1889, doktor telah dilantik untuk menjaga kesihatan pekerja. Bagaimanapun pada waktu itu, doktor ditugaskan untuk menjaga kebersihan dan mengawal penyakit berjangkit di kalangan pekerja. Penglibatan doktor dalam perkhidmatan kesihatan pekerjaan semakin bertambah sehingga tahun 1978, apabila termaktubnya Akta Penjagaan Kesihatan Pekerjaan (Occupational Health Care Act) yang menumpukan kepada perkhidmatan pencegahan dan kuratif. Konsep OHS di Finland adalah dengan melihat sesuatu tempat kerja itu sebagai sakit atau sihat yakni status sakit bukan hanya dilihat kepada individu kerja sahaja (Halemaki-Aro R., 2021). Pusat-pusat kesihatan perbandaran/daerah yang memang ditugaskan untuk menjaga perkhidmatan primer dan pencegahan di bawah Akta Penjagaan Kesihatan Finland, telah juga ditugaskan untuk menyediakan anggota kesihatan untuk menjaga aspek-aspek kesihatan pekerjaan di tempat-tempat kerja di seluruh Finland terutamanya di industri kecil. Di pusat kesihatan yang lebih besar, Bahagian Kesihatan Pekerjaan multidisiplinari dibentuk bagi menjaga semua industri-industri lain. Seiring itu, terdapat juga unit kesihatan pekerjaan bagi syarikat-syarikat dan pusat kesihatan swasta yang membekalkan perkhidmatan yang sama. Akta ini seterusnya telah dipinda dari masa ke semasa dengan meningkatkan komponen kandungan perkhidmatan dan latihan mengikut prinsip *Good Occupational Health Practice* (Finnish Ministry of Social Affairs and Health, 2021).

Bagi United Kingdom, penglibatan doktor di dalam memastikan kesihatan pekerja bermula sejak tahun 1833 di mana Akta Kilang yang tertubuh ketika itu melarang pengambilan kerja bagi mereka berusia kurang dari 18 tahun. Majikan perlu mendapatkan sijil bukti umur (*proof of age certificate*) dari doktor yang dikenali sebagai Ahli Bedah Bertauliah (*certified surgeon*) (Eves D., 2014). Pada tahun 1844, dengan penambahbaikan Akta Kilang tersebut, Ahli Bedah Bertauliah telah dilantik oleh pihak kerajaan untuk membantu dalam penyiasatan dan pelaporan kes-kes kecederaan di tempat kerja. Pada ketika ini juga, majikan-majikan digalakkan menggajikan sendiri doktor bagi memantau keselamatan dan kesihatan pekerja-pekerja kilang mereka. Pada tahun 1895, doktor-doktor telah mula diarahkan untuk melaporkan kes-kes penyakit pekerjaan seperti anthraks pekerjaan dan keracunan plumbum, fosforus dan arsenik kepada Ketua Inspektor Kilang. Majikan juga perlu melaporkan kes berpenyakit kepada Ahli Bedah Bertauliah bagi tujuan penyiasatan. Pada tahun 1930, istilah Ahli Bedah Bertauliah telah diubah kepada Doktor Kilang Bertauliah (Appointed Factory Doctor (AFD) di mana mereka diiktiraf untuk membuat pemeriksaan perubatan kepada pekerja yang terdedah kepada risiko kerja yang diperuntukkan di bawah perundangan. Ketika itu, kebanyakan AFD adalah merupakan doktor perubatan yang mengamalkan perubatan am (*general practice*). Pada tahun 1974, Akta Kesihatan dan Keselamatan Pekerjaan dibentuk bagi memantapkan perundangan berkaitan kesihatan pekerjaan di UK dan susulan itu, Peraturan

Pengurusan Kesihatan dan Keselamatan Pekerjaan 1999 telah digubal. Peraturan ini telah digariskan berdasarkan konsep '*as far as practicable'* dan peranan serta tanggungjawab yang besar telah diletakkan kepada majikan untuk memastikan kesihatan dan keselamatan pekerja. OHD merupakan salah satu pemberi khidmat kesihatan pekerjaan yang boleh dilantik oleh majikan sebagai orang yang kompeten (OYK) bagi membantu beliau memenuhi keperluan perundangan berkaitan (Health & Safety Executive, 2000).

3.2 Peruntukan Asas Berkaitan OHD di Bawah Perundangan Keselamatan dan Kesihatan Pekerjaan Semasa

Bagi melihat peruntukan di dalam perundangan semasa, akta-akta bagi setiap negara telah dianalisis iaitu Kod Pekerjaan (Pindaan 2017) bagi Perancis (Code de Travail, 2021), Akta Keselamatan dan Kesihatan Industri (Pindaan 2006) untuk negara Jepun (Industrial Safety and Health Act, 2021), Akta Kondisi Kerja (Pindaan 2017) bagi negara Belanda (Dutch Working Conditions Decree, 2021), Akta Penjagaan Kesihatan Pekerjaan (Pindaan 2001) bagi Finland (Occupational Health Act, 2001) dan Peraturan Pengurusan Kesihatan dan Keselamatan Pekerjaan 1999 bagi UK (The Management of Health and Safety at Work Regulations, 1999).

Peruntukan perundangan bagi OHD adalah berbeza dari sebuah negara ke negara yang lain (Jadual 3.1) Secara amnya, keperluan perkhidmatan OHD telah dikaitkan dengan keperluan OHS. Keperluan membekalkan OHS kepada semua pekerja secara perundangan telah dinyatakan dengan jelas bagi negara Perancis, Belanda dan Finland. Bagi negara Jepun, pemberian OHS adalah wajib bagi pekerja-pekerja yang bekerja di syarikat atau organisasi yang mempunyai bilangan pekerja seramai 50 orang atau lebih. Negara Perancis dan Jepun telah memperincikan lagi peruntukan keperluan OHD mengikut bilangan pekerja. Syarikat atau organisasi di Perancis dengan jumlah pekerja 5000 orang atau lebih dan juga yang mempunyai jumlah pekerja 3000 di mana sekurang-kurangnya 100 daripada mereka berisiko tinggi, haruslah mempunyai seorang OHD syarikat yang bekerja sepenuh masa. Manakala bagi syarikat dengan jumlah pekerja yang kurang dari jumlah tersebut, majikan boleh mendapatkan perkhidmatan OHD melalui perkhidmatan kesihatan pekerjaan antara-syarikat (*inter-company*). Di Jepun pula, majikan yang mempunyai bilangan pekerja 50 orang atau lebih perlu melantik seorang OHD untuk menguruskan aktiviti kesihatan pekerjaan. Jika jumlah pekerja melebihi 3000 orang, maka 2 orang atau lebih OHD perlu dilantik. Di samping itu, bagi majikan yang mempunyai sekurang-kurangnya 500 orang pekerja yang bekerja di tempat kerja yang berisiko tinggi, mereka perlu mempunyai seorang OHD yang diambil bekerja secara eksklusif di syarikat tersebut. Bagi UK pula, ia tidak dinyatakan secara terperinci. Mengikut Peraturan Pengurusan Kesihatan dan Keselamatan Pekerjaan (1999), majikan diberi tanggungjawab untuk menentukan bilangan orang kompeten yang diperlukan mengikut saiz, syif dan risiko pekerja yang ada.

Mengenai tahap kelayakan, OHD perlulah bertaraf pakar perubatan kesihatan pekerjaan bagi melaksanakan tugas-tugas yang diperuntukkan oleh perundangan bagi negara Perancis dan Belanda. Bagaimanapun, bagi Jepun, Finland dan UK, OHD boleh merupakan seorang doktor yang telah mendapat latihan asas atau pascasiswazah berkaitan keselamatan dan kesihatan pekerjaan yang diiktiraf oleh badan profesional perubatan tersebut seperti Fakulti Perubatan Pekerjaan UK (British Medical Association, 2017) dan Persatuan Perubatan Jepun (Nagata et al., 2016, Mori K., 2018) Di negara-negara ini, terdapat juga perkhidmatan kepakaran yang boleh dirujuk oleh OHD bukan pakar seperti di institut-institut kesihatan pekerjaan atau universiti (Eaton et al 2017, WHO 2012). Di Jepun, OHD bukan pakar boleh mendapat nasihat kepakaran dari Persatuan Perubatan atau Pusat Promosi Kesihatan Pekerjaan Perbandaran/Daerah di bawah Jabatan Kesihatan dan Keselamatan (Imamura & Tanaka, 2011).

Jadual 3.1 Peruntukan Asas Berkaitan OHD Di Bawah Perundangan Keselamatan dan Kesihatan Pekerjaan Semasa Mengikut Negara

Peruntukan	Perancis	Japan	Belanda	Finland	United Kingdom
Perundangan berkaitan OHS dengan keperluan OHD	Kod Pekerjaan (Pindaan 2017) Buku 4	Akta Keselamatan dan Kesihatan Industri (Pindaan 2006)	Akta Kondisi Kerja (Pindaan 2017)	Akta Penjagaan Kesihatan Pekerjaan (Pindaan 2001)	Peraturan Pengurusan Kesihatan dan Keselamatan Pekerjaan 1999)
Penekanan peranan OHD di awal penubuhan Akta berkaitan	Preventif dan Forensik	Perkhidmatan kesihatan primer	Preventif dan Rehabilitasi	Preventif dan Kuratif	Preventif dan Forensik
Keperluan liputan perkhidmatan OHD	Semua tempat kerja	Tempat kerja dengan populasi pekerja >50 orang	Semua tempat kerja	Semua tempat kerja	Tidak dinyatakan
Nisbah pekerja dan OHD	OHD *in-plant:* - ≥5,000 pekerja - ≥3,000 pekerja dengan lebih 100 pekerja berisiko tinggi	≥2 OHD jika ≥3,000 pekerja. OHD *in-plant* : ≥1,000 pekerja atau ≥500 pekerja berisiko tinggi	Tidak dinyatakan	Tidak dinyatakan	Tidak dinyatakan
Status minima tahap kelayakan OHD di dalam memberi perkhidmatan OHS	Pakar perubatan kesihatan pekerjaan	Bukan pakar tetapi mempunyai latihan asas keselamatan dan kesihatan pekerjaan	Pakar perubatan kesihatan pekerjaan	Bukan pakar tetapi mempunyai latihan asas keselamatan dan kesihatan pekerjaan	Bukan pakar tetapi mempunyai latihan asas keselamatan dan kesihatan pekerjaan

3.3 Perkhidmatan OHD di Bawah Perundangan Berkaitan Perkhidmatan Kesihatan Pekerjaan Mengikut Negara.

Keperluan perkhidmatan OHD telah diperuntukkan secara perundangan di semua negara. Bagaimanapun terdapat perkara yang tidak dijelaskan secara langsung tetapi digariskan secara tidak langsung di dalam peruntukan bagi OHS.

3.3.1 Model Pemberian Perkhidmatan OHD

Terdapat pelbagai model pemberian perkhidmatan OHD di semua negara yang ditinjau (Jadual 3.2). Pada amnya, OHD boleh bertugas di dalam syarikat itu sendiri atau di luar. Bagi perkhidmatan yang diberi dari luar, ianya boleh melibatkan pusat perkhidmatan swasta secara persendirian atau berkumpulan. Bagaimanapun, bagi negara Finland perkhidmatan OHS wajib diberikan oleh pusat kesihatan primer kerajaan yang berada di bawah seliaan pihak majlis perbandaran/daerah. Walaupun begitu, majikan boleh mengambil perkhidmatan dari pusat-pusat swasta yang lain dan perkhidmatan ini boleh dibayar balik oleh kerajaan mengikut skim insurans negara tersebut.

3.3.2 Tanggungjawab OHD Di Dalam Pengurusan Kesihatan Pekerjaan Peringkat Syarikat/ Organisasi Serta Perlindungan OHD Di Dalam Menjalankan Tanggungjawab.

Bagi semua negara lain, OHD adalah bersifat bebas atau *independent* walaupun mereka dibayar untuk perkhidmatan. Secara amnya mereka mempunyai peranan sebagai penasihat kepada majikan agar mereka dapat memenuhi kehendak perundangan yang ditetapkan. Walaupun begitu, terdapat negara yang memberikan tanggungjawab yang lebih besar kepada OHD di dalam perundangannya. Mereka turut bertanggungjawab kepada beberapa perkara yang berkaitan dengan OHS. Mengenai perlindungan kepada OHD di dalam menjalankan tugas yang termaktub di dalam perundangan, OHD di negara Perancis dilindungi dengan sangat ketat. Ini mungkin kerana tanggungjawab yang sangat luas diletakkan kepada mereka. Secara perundangan, mereka merupakan ketua bagi perkhidmatan OHS di sesuatu tempat kerja dan mereka merupakan salah seorang dari ahli Jawatankuasa Keselamatan Kesihatan Pekerjaan sesebuah syarikat. Oleh itu mereka terlibat secara langsung dengan polisi syarikat berkaitan kesihatan pekerjaan dan tindakan yang mereka lakukan haruslah berkoordinasi bersama majikan, pekerja dan pihak lain yang berkaitan. Mereka perlu membentuk perancangan tahunan keselamatan dan kesihatan pekerjaan. Sebarang cadangan yang diberikan oleh mereka perlu diikuti oleh majikan. Jika majikan tidak berpuas hati dengan cadangan yang diberikan atau tidak dapat memenuhinya maka majikan boleh membawa ke tribunal industri tanpa melibatkan OHD tersebut. Perkara ini akan dibincangkan antara Badan Penguatkuasaan (Inspektorat) Kesihatan pekerjaan dan majikan. OHD tidak boleh dengan sewenang-wenangnya dipecat tanpa alasan yang kukuh. Sebarang niat pemecatan OHD mestilah dibawa ke Jawatankuasa Ekonomi dan Sosial atau Lembaga pengarah Organisasi Perkhidmatan Kesihatan Pekerjaan Antara-syarikat. Perkara yang sama berlaku di negara Jepun di mana OHD juga terlibat di dalam mesyuarat JKKP tetapi mereka hanya melaporkan cadangan dan aktiviti mereka sahaja. Bagi perlindungan perundangan kepada OHD, majikan tidak boleh mengetepikan cadangan yang diberikan oleh OHD dan tidak boleh bertindak atau memecat OHD tanpa alasan yang munasabah. Bagaimanapun, jika dibandingkan dengan negara Perancis, peruntukan perundangan dari segi pemecatan OHD adalah kurang diperincikan (Matsuda S., 2012).

Bagi negara Belanda, setelah kontrak perkhidmatan dilakukan, OHD turut bertanggungjawab untuk memenuhi kehendak perubatan berkaitan kesihatan pekerjaan mengikut perundangan seperti menasihati majikan di dalam pembentukan polisi ketidakhadiran bekerja. Pembahagian tugas yang terperinci antara OHD dan majikan perlu dijelaskan di dalam kontrak tersebut. Bagi perlindungan OHD pula, beliau perlu menyatakan di dalam kontrak perkhidmatan bagaimana aduan bagi perkhidmatannya dapat dilakukan dan pihak yang akan memberikan kata putus terhadap aduan tersebut.

Bagi negara Finland, perundangan hanya menjelaskan bahawa OHD bertanggungjawab memberikan perkhidmatan mengikut amalan *good occupational health care practices* dan memberi kepada majikan dan JKKP maklumat yang diperlukan untuk jaminan kesihatan pekerja dan pembentukan tempat kerja yang sihat. Dari segi tindakan perundangan, OHD di Finland adalah dilindungi apabila memberikan maklumat kepada pihak berwajib seperti yang diperlukan seperti notifikasi penyakit. Bagi negara UK, peranan OHD di dalam pengurusan kesihatan pekerjaan peringkat syarikat tidak dinyatakan. Begitu juga dengan kaedah perlindungan OHD. Ini mungkin berlaku kerana tanggungjawab banyak diletakkan kepada majikan. Majikan perlu melantik OHD dan ahli-ahli perkhidmatan kesihatan pekerjaan yang lain mengikut '*fit for purpose'* dan memastikan terdapat koordinasi dan kerjasama di antara mereka yang dilantik. Peraturan berkaitan notifikasi Penyakit Pekerjaan (RIDDOR 2013) juga mewajibkan majikan dan bukannya OHD untuk melaporkan penyakit pekerjaan kepada pihak berwajib. Model perkhidmatan OHS di UK lebih menumpukan kepada promosi berbanding perundangan. Agensi penguatkuasaan dan kerajaan mereka serta agensi profesional dan lain-lain lebih banyak mengeluarkan panduan bagi majikan untuk melantik orang yang kompeten serta panduan amalan kepada orang yang kompeten seperti Kod Amalan Industri (Health & Safety Executive, 2003) untuk dipatuhi.

Jadual 3.2 Perkhidmatan OHD Di Bawah Perundangan Berkaitan Perkhidmatan Kesihatan Pekerjaan Mengikut Negara

Negara	Perancis	Japan	Belanda	Finland	United Kingdom
Kaedah pemberian perkhidmatan	Unit Kesihatan Pekerjaan syarikat Organisasi Perkhidmatan Kesihatan Pekerjaan Antara-syarikat yang diselia oleh Pejabat Pekerjaan Daerah.	Unit Kesihatan Pekerjaan syarikat Pusat Perkhidmatan kesihatan pekerjaan swasta. Pusat kesihatan primer persendirian	Unit Kesihatan Pekerjaan syarikat Pusat Perkhidmatan kesihatan pekerjaan swasta Konsultasi persendirian	Pusat kesihatan perbandaran/daerah Unit Kesihatan Pekerjaan syarikat Unit Kesihatan Pekerjaan bagi gabungan syarikat Pusat Perubatan swasta	Unit Kesihatan Pekerjaan syarikat Pusat Perkhidmatan kesihatan pekerjaan swasta Konsultasi persendirian Pusat Perubatan swasta
Tanggungjawab OHD di peringkat pengurusan kesihatan pekerjaan syarikat.	Secara langsung Membentuk arah tuju aktiviti keselamatan dan kesihatan pekerjaan mengikut perundangan dan menyediakan laporan tahunan tentang keselamatan dan kesihatan pekerjaan syarikat. Menyelaras tindakan di antara majikan, pekerja dan pihak berkaitan. Sebagai ahli mesyuarat Jawatankuasa Keselamatan dan	Secara langsung Membentangkan cadangan dan laporan aktiviti OHD kepada JKKP syarikat. Sebagai ahli mesyuarat Jawatankuasa Keselamatan dan Kesihatan Pekerjaan syarikat.	Secara langsung Berkongsi tanggungjawab bersama majikan bagi memenuhi kehendak perundangan yang berkaitan setelah membuat kontrak perkhidmatan dengan syarikat. Kontrak asas perlu menjelaskan pembahagian tugas OHD dan majikan di dalam menjalankan peruntukan perundangan.	Secara tidak langsung OHD perlu memberi kepada majikan dan JKKP maklumat yang diperlukan untuk menjamin kesihatan pekerja dan membentukkan tempat kerja yang sihat. Dinyatakan bahawa majikan perlu memastikan OHD dapat menguruskan perkhidmatan OHS mengikut *good occupational health care practice.*	Secara tidak langsung Hanya dinyatakan orang yang kompeten (OHD) perlu dilantik oleh majikan bagi membantu beliau memenuhi kehendak perundangan. Kerjasama di antara ahli kesihatan pekerjaan multidisiplinari adalah dibawah tanggungjawab majikan.

	Kesihatan Pekerjaan syarikat. Mengetuai pasukan multidisiplinari OHS.				
Perlindungan tugas OHD yang termaktub di dalam perundangan.	Sebarang niat pemecatan OHD mestilah dibawa ke Lembaga pengarah Organisasi Perkhidmatan Kesihatan Pekerjaan Antara-syarikat atau Jawatankuasa Ekonomi dan Sosial.	Majikan tidak boleh mengetepikan cadangan yang diberikan oleh OHD dan tidak boleh bertindak atau memecat OHD tanpa alasan yang munasabah.	OHD perlu menyatakan di peringkat awal kontrak bagaimana aduan terhadap perkhidmatannya boleh dilakukan dan ditetapkan siapa yang akan membuat keputusan mengenai aduan tersebut.	OHD dilindungi di dalam memberikan maklumat seperti yang diminta oleh Kementerian Kebajikan Sosial dan Kesihatan atau wakilnya.	Tidak dinyatakan Hanya menyatakan bahawa majikan turut bertanggungjawab di atas tindakan orang yang kompeten (OHD) yang dilantik dari segi memenuhi kehendak perundangan.
Fungsi di bawah perkhidmatan OHS	Melakukan tindakan di tempat kerja supaya kesihatan fizikal dan mental pekerja sentiasa terjaga di sepanjang kerjaya. Menasihati majikan, pekerja dan wakil mereka mengenai peruntukan dan langkah kawalan dan pencegahan pendedahan risiko kesihatan pekerjaan termasuk pengambilan dadah dan alkohol di tempat kerja serta	Melakukan pemeriksaan kesihatan. Menyiasat punca penyakit pekerjaan dan mencegah daripada ianya kembali berlaku. Mengurus persekitaran pekerjaan melalui rondaan bulanan di tempat kerja Memberi pendidikan kesihatan Memberi bimbingan secara bersemuka kepada	Menjalankan tanggungjawab mengikut teknologi dan dapatan saintifik terkini. Memberi nasihat mengenai implementasi keadaan kerja yang sesuai serta polisi tidak kehadiran bekerja dengan mengambilkira kumpulan pekerja tertentu dan perkara yang telah berlaku di tempat kerja. Menaksir pendedahan hazad yang berlaku akibat	Menyiasat dan menaksir kebolehan sesuatu pekerjaan untuk menjamin kesihatan pekerja melalui lawatan ke tempat kerja (*promotion*). Menyiasat, menaksir dan memantau risiko kesihatan pekerjaan. Memberi cadangan tindakan penambahbaikan dan mempromosi kapasiti kerja dan fungsi pekerja.	Tidak dinyatakan dengan terperinci Majikan hanya diminta untuk memastikan OHD (OYK) melakukan apa yang majikan rasakan perlu (fit for purpose) di dalam menaksir dan mengawal risiko

gangguan moral dan seksual di tempat kerja.

Memantau status kesihatan pekerja mengikut kesan pendedahan faktor risiko.

Terlibat di dalam pemantauan pendedahan pekerjaan dan mengesannya melalui pemantauan kesihatan.

pekerja yang kerja berlebihan.

Memberi bimbingan secara bersemuka kepada pekerja berdasarkan saringan stres.

teknologi, organisasi dan kelakuan manusia serta perkara yang telah berlaku di tempat kerja.

Menilai, menjaga dan menguruskan aduan mengenai perkhidmatan.

Memberi maklumat, nasihat dan panduan berkaitan kesihatan dan keselamatan pekerjaan termasuk menyiasat bebankerja jika dimohon oleh pekerja.

Memantau dan menyokong keupayaan bekerja bagi pekerja yang mempunyai disabiliti.
Memberi kerjasama dengan pihak yang berkaitan seperti badan berkuasa dan ahli perkhidmatan kesihatan pekerjaan yang lain.

Terlibat di dalam menguruskan first aid

Membantu di dalam cadangan dan pengurusan langkah-langkah promosi keupayaan bekerja termasuk siasatan keperluan rehabilitasi.

Menaksir dan memantau kualiti dan kesan aktiviti perkhidmatan kesihatan pekerjaan.

Hak untuk akses di tempat kerja	Mempunyai Akses bebas (free access) Malah perlu memperuntukan 1/3 dari masa bekerja untuk aktiviti di tempat kerja.	Mempunyai akses bebas (free access) Malah perlu melakukan rondaan tempat kerja sekurang-kurangnya sebulan sekali.	Mempunyai akses bebas (*free access*)	Mempunyai akses bebas (free access)	Tidak dinyatakan secara terpeinci Majikan diarah untuk membekalkan OHD dengan maklumat yang mereka perlukan.
Tugas lain yang dibenarkan selain OHD	Tidak dibenar membuat amalan rawatan klinikal kecuali rawatan kecemasan.	Tiada limitasi. Boleh menjadi pakar dalam bidang perubatan yang lain dalam masa yang sama.	Tidak dinyatakan	Tiada limitasi. Boleh terlibat di dalam rawatan klinikal yang tidak berkaitan dengan pekerjaan.	Tidak dinyatakan

3.3.3 Fungsi OHD Di Bawah Perkhidmatan OHS.

Di dalam perundangan berkaitan OHS, terdapat fungsi OHD yang digariskan secara terperinci dan ada yang hanya dijelaskan secara am sebagai peranan umum ahli-ahli OHS iaitu termasuk pengamal higen industri, jururawat kesihatan pekerjaan dan ahli ergonomik. Fungsi OHD sebagai penasihat kepada majikan adalah jelas bagi semua negara iaitu dari segi tindakan kawalan dan pencegahan berkaitan penyakit dan keupayaan bekerja. Fungsi kepada pekerja pula lebih kepada aktiviti individu seperti melakukan juga pemeriksaan kesan kesihatan mengikut pendedahan risiko, penyiasatan punca penyakit, bimbingan bersemuka dan menaksir keupayaan bekerja. Bagaimanapun terdapat beberapa penekanan lain di antara negara; contohnya Finland ada menjelaskan mengenai promosi keupayaan bekerja kepada semua pekerja, manakala Belanda meletakkan implementasi keadaan kerja harus dibuat kepada pekerja tertentu atau apa yang telah berlaku di tempat kerja serta penglibatan di dalam polisi tidak kehadiran bekerja. Negara Perancis meletakkan kawalan risiko pengambilan dadah dan alkohol serta gangguan moral dan seksual di tempat kerja sebagai satu penekanan dan Jepun menggariskan bimbingan secara bersemuka kepada pekerja yang mempunyai masalah beban kerja berlebihan dan stres. Nasihat dan panduan berkaitan masalah beban kerja juga ada termaktub di dalam perundangan bagi negara Finland.

3.3.4 Hak Untuk Akses Di Tempat Kerja.

Akses kepada tempat kerja merupakan satu hak bagi OHD yang termaktub secara perundangan bagi semua negara kecuali UK. Jika dilihat dari segi fungsi OHD yang telah digariskan di semua negara, akses ini adalah perlu bagi membolehkan OHD menyiasat pendedahan risiko dan memberikan cadangan penambahbaikan di tempat kerja tanpa mengira kaedah pemberian perkhidmatan mereka. Di negara Perancis dan Jepun, semua OHD telah ditetapkan di bawah perundangan untuk memasuki dan bertugas di tempat kerja secara berkala. Bagaimanapun, akses kepada tempat kerja tidak dinyatakan di dalam perundangan UK (Health & Safety Executive, 2003). Ini mungkin kerana perundangan kesihatan dan keselamatan di UK lebih menekankan kepada kewajipan majikan di dalam menentukan tahap kesihatan dan keselamatan kesihatan pekerja yang tinggi. Oleh itu telah digariskan bahawa majikan yang berperanan untuk memastikan perkhidmatan yang diperlukan dapat dibuat dengan baik oleh pelbagai pemberi perkhidmatan yang dilantik secara kontrak.

3.3.5 Tugas lain yang dibenarkan selain melakukan tugas berkaitan kesihatan pekerjaan.

Pada amnya, OHD dibenarkan melakukan tugas-tugas lain selain tugas OHD terutamanya bagi negara yang mempunyai OHD bukan pakar. Hanya negara Perancis yang tidak membenarkan OHD melakukan aktiviti rawatan klinikal kecuali bagi rawatan kecemasan. Keputusan ini berlaku di peringkat awal pembentukan perkhidmatan OHD di mana terdapat ramai doktor yang melakukan kerja OHD secara separuh masa yang sering memberikan perkhidmatan perubatan yang tidak diperlukan serta isu diagnosis bagi tujuan cuti sakit (Matsuda S., 2012). Di negara ini, OHD juga tidak dibenarkan bekerja di perkhidmatan klinik swasta.

4.0 PERBINCANGAN

Dari dapatan tinjauan literatur ini, dapatlah kita simpulkan bahawa setiap 5 negara tersebut telah meletakkan OHD sebagai pemberi utama perkhidmatan kesihatan pekerjaan sejak dari awal penubuhan perkhidmatan ini. Kajian yang dijalankan oleh *International Commission of Occupational Health* (ICOH) pada 2015 juga mencerminkan kesinambungan penglibatan OHD sehingga ke saat ini di mana dari 49 negara yang dikaji, semua (100%) negara mempunyai OHD di dalam sistem perkhidmatan kesihatan pekerjaan mereka berbanding jururawat kesihatan pekerjaan (69%), ahli higen industri (67%), ahli ergonomik (63%) dan ahli psikologi pekerjaan (31%) (Rantanen et al., 2017). Pun begitu, bukan semua negara yang ditinjau memperuntukkan penglibatan OHD di dalam OHS secara perundangan. Bagi peruntukan nisbah pekerja dan OHD, hanya 2 negara yang memberikan peruntukan tersebut di dalam perundangan.

Mengenai kelayakan OHD, hanya 2 negara yang ditinjau menetapkan bahawa OHD mestilah bertaraf pakar. Manakala negara-negara yang lain membenarkan semua doktor yang hendak mengamalkan bidang kesihatan pekerjaan hanya mengambil kursus latihan asas atau latihan pasca siswazah kesihatan pekerjaan. Jika kita melihat kaitan kelayakan dan tugas lain OHD yang dibenarkan, maka dapat dilihat bahawa negara yang membenarkan OHD tanpa kepakaran untuk berfungsi juga turut membenarkan OHD mengamalkan bidang perubatan yang lain manakala bagi OHD pakar, bidang tugas selain OHD yang dibenarkan adalah lebih restriktif. Perkhidmatan mereka adalah tertumpu kepada bidang kesihatan pekerjaan dan diiktiraf sebagai pakar perunding di dalam bidang ini. Juga, jika kita melihat kepada kelayakan, tanggungjawab, amalan perubatan yang dibenarkan dan perlindungan perundangan kepada OHD untuk menjalankan tugas dapatlah dirumuskan bahawa tanggungjawab yang tinggi, keperluan taraf kepakaran dan pengekangan amalan yang boleh dilakukan oleh OHD menjelaskan perlindungan yang diberi kepada OHD di dalam perundangan. Contohnya di negara Perancis, OHD ditugaskan untuk memikul tanggungjawab yang tinggi beserta perlu mempunyai taraf pakar dan tidak dibenarkan melakukan amalan perubatan yang lain telah diberi perlindungan yang jelas dengan prosedur yang ketat bagi pemecatan mereka. Bagaimanapun, tiada pernyataan mengenai perkara ini di dalam perundangan di UK kerana OHD hanya merupakan salah seorang dari ahli-ahli perkhidmatan OHS yang dilantik oleh majikan. Oleh itu, pemecatan OHD dan perlindungan lain akan hanya berada di dalam kontrak perkhidmatan.

Walaupun di awal penubuhan Akta berkaitan perkhidmatan kesihatan pekerjaan, peranan doktor adalah berbeza, namun dengan pindaan-pindaan yang dilakukan didapati OHD di semua negara mempunyai peranan yang hampir sama iaitu peranan berbentuk pencegahan. Akta ini merupakan terjemahan kepada objektif dan peranan perkhidmatan kesihatan pekerjaan yang didefinisikan di peringkat antarabangsa di dalam *ILO Occupational Health Services Convention 1985 (No. 161).* Akta ini menyatakan bahawa perkhidmatan OHS adalah khusus untuk peranan pencegahan dan bertanggungjawab di dalam menasihati majikan, pekerja dan wakil mereka di industri di dalam keperluan untuk mewujudkan dan mengekalkan persekitaran kerja yang selamat dan sihat yang akan mengoptimumkan kesihatan fizikal dan mental berhubung dengan pekerjaan. Akta ini juga menyatakan peranan OHS adalah bagi penyesuaian kerja dengan kemampuan pekerja dengan mengambil kira keadaan kesihatan fizikal dan mental mereka. Maka, dapat dilihat bahawa peranan OHD di semua negara menekankan kepada peranan untuk menasihati majikan, pekerja dan wakil mereka di dalam dua perkara iaitu untuk memastikan persekitaran kerja optimum bagi kesihatan pekerja dan memastikan penyesuaian kerja dibuat mengikut kemampuan pekerja. Bagaimanapun terdapat sedikit perbezaan di negara-negara ini dari segi julat penekanan tanggungjawab pengurusan kepada OHD. OHD di Perancis, umpamanya, ditugaskan untuk merancang arah tuju aktiviti kesihatan pekerjaan di tempat kerja termasuk menjadi ketua bagi pasukan keselamatan dan kesihatan pekerjaan multidisiplinari manakala di UK, mereka merupakan hanya salah seorang dari ahli pasukan tersebut dan kebanyakan peranan pengurusan tersebut digalas oleh majikan.

Dari segi fungsi OHD di bawah perkhidmatan OHS, fungsi OHD di semua negara merupakan terjemahan fungsi OHS yang digariskan di dalam *ILO Occupational Health Services Recommendation 1985 (No. 171).* Fungsi-fungsi yang digariskan oleh ILO adalah survelan/pengawasan persekitaran kerja, penilaian kesihatan pekerja, pemberian nasihat, pendidikan serta latihan dan pemberian rawatan kecemasan serta program kesihatan (Rajah 3.1). Pun begitu, negara-negara yang ditinjau mempunyai penekanan masing-masing di dalam fungsi ini, Ini mungkin kerana mengambil kira masalah dalam kalangan pekerja mengikut negara masing-masing. Contohnya di negara Jepun isu beban kerja berlebihan yang dihadapi oleh pekerja-pekerja merupakan satu masalah nasional. Istilah *Karoshi* iaitu kematian akibat beban kerja berlebihan juga datangnya dari bahasa Jepun yang melambangkan beban masalah ini di negara tersebut. Oleh yang demikian, peranan OHD yang diperuntukkan khas di dalam perundangan untuk memberi bimbingan bersemuka dengan pekerja mengenai beban kerja

berlebihan adalah sesuatu yang dijangkakan. Begitu juga dengan perundangan lain, ia dapat mempengaruhi fungsi OHD di sesebuah negara tersebut. Contohnya di Belanda, kita dapat melihat bahawa OHD perlu terlibat di dalam polisi ketidakhadiran pekerja, terutamanya berkaitan dengan cuti sakit. Ini kerana majikan perlu bertanggungjawab di atas bebanan kewangan kerana ketidakhadiran bekerja pekerja yang mempunyai disabiliti dalam tempoh yang ditetapkan di bawah perundangan berkaitan insurans disabiliti.

Untuk akses kepada tempat kerja, pemberian akses bebas kepada OHD adalah jelas dan munasabah kerana peranan dan fungsi mereka melibatkan aktiviti penaksiran, kawalan dan pencegahan di tempat kerja. Pun begitu, perkara ini tidak dinyatakan di dalam perundangan di UK. Ini mungkin kerana perundangan kesihatan dan keselamatan di UK lebih menekankan kepada kewajipan majikan di dalam menentukan tahap kesihatan dan keselamatan kesihatan pekerja yang tinggi. Telah digariskan bahawa majikanlah yang berperanan untuk memastikan perkhidmatan yang diperlukan dapat dibuat dengan baik oleh pelbagai pemberi perkhidmatan yang dilantik secara kontrak. Oleh itu, akses kepada tempat kerja adalah mengikut pertimbangan majikan berpandukan perbincangan bersama OHD. Secara keseluruhan, perundangan berkaitan OHS di UK hanya meletakkan apa yang harus dicapai, tetapi kaedah perlaksanaan ditentukan oleh majikan dengan disokong oleh dokumen panduan oleh pihak berwajib atau badan profesional negara tersebut.

Terdapat beberapa limitasi di dalam tinjauan ini. Pertama, analisis akta-akta berkaitan hanya berpandukan kepada terjemahan mereka kepada bahasa Inggeris kecuali bagi UK dan Perancis kerana terdapat penyelidik-penyelidik yang fasih di dalam kedua-dua bahasa tersebut. Limitasi kedua adalah tiada negara di rantau ASEAN yang mungkin sesuai dikaji tetapi tidak dimasukan di dalam tinjauan. Perkara ini berlaku kerana terdapat masalah ketersediaan dokumen untuk diguna sebagai rujukan. Memandangkan limitasi-limitasi ini, perbincangan bersama pemegang taruh di negara-negara yang ditinjau adalah dicadangkan bagi meningkatkan dapatan di dalam kajian yang akan datang.

5.0 KESIMPULAN

OHD merupakan pengamal kesihatan pekerjaan yang diperlukan bagi melaksanakan peranan dan fungsi perkhidmatan kesihatan pekerjaan di sesebuah negara. Peruntukan perkhidmatan OHD perlu digariskan di dalam perundangan bagi menjelaskan tanggungjawab dan hak OHD di dalam perkhidmatan ini. Kaedah pemberian perkhidmatan OHD adalah pelbagai dan litupan perkhidmatan OHD boleh ditentukan melalui jumlah keseluruhan pekerja atau mengikut bilangan pekerja berisiko. Tanggungjawab, peranan dan fungsi OHD perlulah seimbang dengan taraf kelayakan, hak dalam menjalankan tugas serta hak perlindungan OHD dari segi perundangan untuk menjamin perkhidmatan OHD yang komprehensif dan sempurna bagi sesebuah negara.

PENGHARGAAN

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Review Article

A Review on the Effectiveness of Surgical Mask and N95 Respirator Used During COVID-19 Pandemic

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ABSTRACT : *A pandemic is defined as the worldwide spread of a new disease. New strains emerge and cause pandemics from time to time. While influenza viruses are found to be spread by human to human contact through respiratory droplets, infected persons including those who handle them, are urged to wear facemasks like N95 respirators or surgical masks. This review article shares a performance comparison of N95 and surgical masks during a pandemic. As N95 respirators and surgical masks have different functions, studies have been done to compare the effectiveness of both the facemasks in preventing people from being infected with the viruses. However, there is still a lack of data supporting the use of facemasks to prevent spread of infection. In conclusion, this article recommends N95 respirators or surgical masks usage to people with suspected or confirmed infection and those who handle them.*

Keywords - *Coronavirus disease 2019, healthcare, N95 respirator, pandemic, surgical mask*

1.0 INTRODUCTION

The World Health Organization (WHO) defines pandemic as the worldwide spread of a new disease. An influenza pandemic occurs when a new virus emerges and spreads worldwide (WHO, 2010). There is also a newly discovered coronavirus called severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) which causes coronavirus disease 2019 (COVID-19). It is an infectious disease where mild to moderate respiratory illness is experienced by majority of the infected patients (WHO, 2020). Both SARS-CoV-2 and Influenza pandemics are making people sick and ill. Influenza is said to spread from person to person in a structured and sustained manner (Centers for Disease Control and Prevention, 2016); WHO clarifies that the main transmission of influenza occurs through exposure to large particle (>5 micron) from respiratory droplets when someone coughs or sneezes (WHO, 2006). Similarly, for COVID-19, the spread occurs primarily through droplets of saliva or sneeze of an infected person (WHO, 2020). Other than focusing on the primary mode of transmission, it is also important to prevent spread of infection from through hand-to-nose, - eye, and –mouth self-contamination as well as small particle transmission as small particles can remain suspended in air for several meters during procedures, such as suction, aspiration, and intubation (WHO, 2006). Thus, as precaution wearing a facemask for both suspected or infected persons with influenza or COVID-19 and caretakers who handle them, including healthcare workers (HCW) is suggested (WHO, 2018; & WHO, 2020). The facemasks mentioned here are the N95 respirator and surgical mask.

According to Lee et al. (2008), surgical masks provide protection against particles of 0.04–1.3 micron in size, which is 8–12 times less than N95 (Lee et al., 2008). However, both surgical masks and N95 provide more or less the same protection against influenza with low concentrations of infectious viruses (Loeb et al., 2009). This review article shares a performance comparison of N95 and surgical masks during a pandemic. Some experts argue that N95 respirators and medical masks are equivalent in clinical settings (Macintyre et al., 2011; Macintyre et al., 2013; and Loeb et al., 2009). At the same time, laboratory studies designed to achieve 100% intervention adherence have shown that N95 or filtering facepiece (FFP) respirators are more efficacious than medical masks at reducing exposure to aerosols (Institute of Medicine, 2008; Macintyre et al., 2011; and Macintyre et al., 2013).

2.0 N95 RESPIRATOR AND SURGICAL MASK

Respirators are a component of personal protective equipment (PPE), which is used to control occupational hazards among workers. However, it is proven to be less effective compared to administrative control, and significant effort is required by the affected workers (Centers for Disease Control and Prevention, 2015). There are a variety of respirators available in the market, as shown in Fig. 1. Disposable filtering half-facepiece respirators (DFHFRs), placed under air-purifying respirators, are commonly donned by industrial workers and the public (Lee et al., 2016).

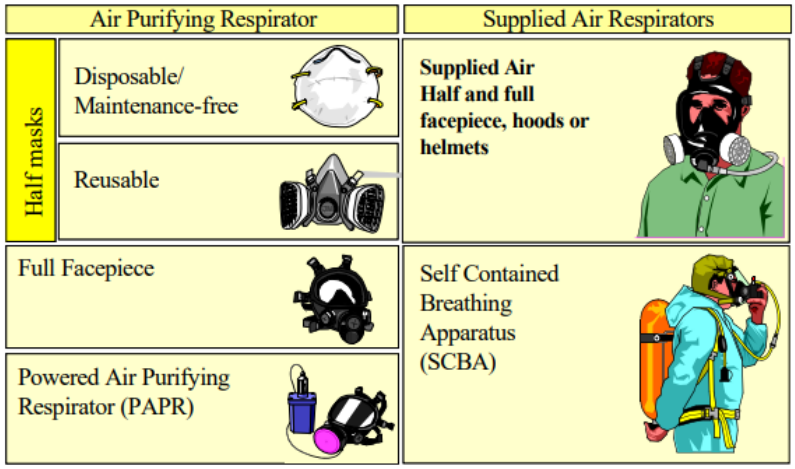

Figure 1 Types of Respirators (Department of Occupational Safety and Health Malaysia, 2005)

In Malaysia, classified by the US National Institute for Occupational Safety and Health (NIOSH), DFHFRs are widely known as N95. N (not resistant to oil) indicates that the respirators cannot be used while working in an oil droplet environment. At the same time, numerical designation 95 indicates the filter's minimum filtration efficiency of 95% (NIOSH, 1996). However, European Standard (EN 149:2001), classifies filtering facepiece respirators into categories of FFP1, FFP2, and FFP3, with a minimum filtration efficiency of 80%, 95%, and 99%, respectively (Lee et al., 2016). Therefore, FFP2 respirators have approximately equivalent minimum filtration efficiencies as that of N95. Thus, both are recommended to prevent airborne infectious diseases in the US and other countries. Meanwhile, Health and Safety Executive only accepts FFP3 respirators to protect against infectious aerosols in healthcare settings in the UK since it provides the highest level of protection (Lee et al., 2016).

As for the surgical mask, its function is to protect the mouth and nose from large particles that may contain microorganisms, such as viruses and bacteria. Large particles mentioned include droplets, splashes, sprays, or splatter (Lee et al., 2016). However, even though surgical masks minimize the exposure of healthcare workers to the saliva and respiratory secretions to the patient and vice versa, they are not recommended to protect people from airborne infectious diseases as it does not form a tight seal against the face. Thus, surgical masks have been said to protect against infection through fluid repellence only (Lee et al., 2016). Contrarily, the Department of Occupational Safety and Health Malaysia (DOSH) does not include surgical masks as respirators. Therefore, they do not count as PPE (DOSH, 2005).

3.0 COMPARISON OF PERFORMANCE OF N95 AND SURGICAL MASK

One randomized trial on surgical mask vs N95 respirator for preventing influenza among HCW conducted among nurses who worked in emergency departments, medical units, and pediatric units in eight Ontario tertiary care hospitals, by Loeb et al. (2009). At the beginning of the influenza season, 212 nurses (included in the analysis) were asked to wear surgical masks. In comparison, 210 nurses (included in the analysis) were given N95 respirators when handling patients with febrile respiratory illness. As long as tuberculosis was not suspected, nurses continued to use the respiratory device they were assigned, including in aerosol-generating procedures, such as intubation or bronchoscopy. At the end of the study, 50 nurses (23.6%) who were assigned with a surgical mask and 48 nurses (22.9%) who wore N95 were found to be positive for laboratory-confirmed influenza (Influenza A and B). In the comment section, the authors stated that surgical masks appeared to be no worse, within a pre-specified margin, than N95 respirators in preventing influenza. However, the N95 mask would provide much better protection from spreading small droplet transmission than the surgical mask, for which the efficiency estimates range from 2– 92% for particles smaller than 20 microns in diameter. One frequently cited concern regarding the surgical mask is its inability to obtain an appropriate seal compared with the N95 respirator. However, the results of the trial in this study showed no concern associated with an increased rate of influenza or other respiratory viruses (Loeb et al., 2009).

The above statements were supported by a new study conducted in 2019. The authors found no significant difference between the effectiveness of N95 respirators and medical masks in preventing laboratory-confirmed influenza among participants routinely exposed to respiratory illnesses in the workplace (Radonovich et al., 2019). The study was similar to the research stated above by Loeb et al. (2009). The objective was to compare the effect of N95 respirators and medical masks to prevent influenza and other viral respiratory infections among health care personnel (HCP) or HCW. This trial was conducted among HCP in diverse outpatient settings serving adult and pediatric patients with a high prevalence of acute respiratory illness. Among 2243 personnel in the N95 respirator group and 2446 in the medical mask group, 371 laboratory-confirmed respiratory illness events occurred in the N95 respirator group, while 417 in the medical mask group (Radonovich et al., 2019).

One systematic review was done to investigate the evidence supporting the effectiveness of face masks in reducing influenza virus infection under controlled and natural conditions by Cowling et al. They reviewed 12 articles comprising three settings: experimental volunteer studies, studies in healthcare settings, and studies in community settings (Cowling et al., 2010). In experimental volunteer studies, Johnson et al. (2009) tested the performance of surgical and N95 masks to filter viruses in nine volunteers with confirmed influenza A or B virus infection. The virus was transferred to a petri dish containing a viral transport medium held 20 cm in front of the participants'' mouth and asking them to cough five times onto the Petri dish. The experiment was repeated with participants wearing a surgical mask and an N95 respirator. Reverse transcription-polymerase chain reaction could detect influenza virus in all nine volunteers without a mask. In contrast, no

influenza virus could be detected on the petri dish specimens when participants wore either type of face mask (Johnson et al., 2009).

A study done by Loeb et al. (2009) was also reviewed in this systematic review study on understudies in healthcare settings. With regards to community settings, an article by MacIntyre et al. (2009) was reviewed. MacIntyre et al. randomized 145 symptomatic index patients aged 0-15 years from outpatient clinics and their household members to three arms: control, surgical masks (worn by household contacts only), or N95-type respirators (worn by household contacts only) without fit-testing. The results showed no difference in influenza-like illness (ILI) in household contacts across intervention arms. However, a secondary per-protocol analysis found that adherent use of N95 or surgical masks significantly reduced ILI risk in household contacts compared to non-adherent mask use or allocation to the control arm (MacIntyre et al., 2009). Therefore, the authors highlighted the limited evidence base supporting the efficiency or effectiveness of face masks to reduce influenza virus transmission (Cowling et al., 2010).

In a case-control study on HCW in a Hong Kong hospital, the risk of severe acute respiratory syndrome (SARS) acquisition for HCW who had direct contact with patients with SARS was not altered by inconsistent use of either type of mask (Lau et al., 2004). These findings were possibly attributable to the study being underpowered and were mirrored in the authors' reanalysis. Authors found that HCW who used N95 or surgical mask during direct contact with patients were neither significantly protected nor significantly at risk for SARS compared with HCW who did not wear a mask (Gralton et al., 2010).

With regards to COVID-19, there are still limited trials on the effectiveness of N95 respirators or surgical masks in preventing the spread of the infectious viruses. However, given the similarity of SARS-CoV in 2002 and SARS-CoV-2, the use of masks and N95 respirators for protection against SARS-CoV-2 is highlighted in China's initial political recommendations. Moreover, it was reasonable to spread awareness regarding wearing a face mask, including N95 respirators, while facing a coronavirus similar to SARS-CoV as both surgical masks and N95 respirators are used to protect against airborne viral pathogens (Wang and Yu, 2020). According to Jefferson et al. (2020) review article on this matter, 67 randomized controlled trials and observational studies found that surgical masks and N95 respirators were supportive measures offering the most consistent protection (Jefferson et al., 2020). This finding is in line with those of Ng et al. (2020). Furthermore, among 85% of HCW who wore a surgical mask, while the rest wore N95 respirators, none acquired infection after exposure to an aerosol-generating procedure. However, the authors emphasized that almost all experts recommend usage of N95 mask or equivalent equipment by the HCW while performing an aerosol-generating procedure (Ng et al., 2020).

Wang et al. retrospectively collected infection data in other studies at six Zhongnan Hospital of Wuhan University departments. The medical staff followed different procedures for occupational protection. One of the procedures was donning N95 respirators, and cleaning and disinfecting hands frequently. Another procedure involved not wearing any masks while cleaning and disinfecting their hands occasionally, as they were not considered a high-risk department in the early days of the outbreak. As a result, they found out that none of the medical staff who wore N95 respirators became infected, while 10 of 213 staff who did not wear any mask were confirmed as infected. This shows that even though the medical staff was in a lower risk department, their infection rate was significantly increased with no respiratory protection (Wang et al., 2020).

Using the same method, Wang et al. (2020) conducted a study on medical staff in Huangmei People's Hospital and Qichun People's Hospital. The results showed a similar outcome to the previous one, where no infected cases among those who wore N95 respirators and frequently cleaned and disinfected hands were found. Therefore, the authors stated that even though previous studies on influenza showed no significant differences between N95 respirators and surgical mask performances, their study showed otherwise. Furthermore, Wang et al. observed that using N95 respirators and hand cleaning and disinfecting appeared to help reduce the infectious risk of COVID-19 among medical staff (Wang et al., 2020). In summary, both N95 and surgical masks showed protective roles in other diseases that could also be translated to the fight against SARS-CoV-2, but their specific contribution remains to be quantified.

A review summary of related work of literature is presented in Table 1. There is still limited evidence to support the effectiveness of either surgical masks or N95 respirators to protect HCW. One recent large trial in nurses found no difference in effectiveness between surgical masks and N95 respirators. However, the confidence intervals were wide enough to include moderate effect sizes (Loeb et al., 2009). Further, more extensive studies are required to confirm the non-inferiority of surgical masks. Finally, there are likely to be difficulties in ensuring compliance among HCW (Seale et al., 2009). Nevertheless, PPE has led to significant improvements in general infection control procedures in the hospital setting (Lu et al., 2006; Casanova et al., 2009; & Rutala and Weber, 2001).

Table 1 Review Summary of Related Literatures

Study	Participants/ Articles	Study design	Findings
Loeb et al. (2009)	422 nurses (212 nurses – assigned to a surgical mask group and 210 nurses assigned to the N95 respirator group)	Randomized clinical trial	50 nurses (23.6%) in the surgical mask group and 48 nurses (22.9%) in the N95 respirator group were found to be positive for laboratory-confirmed influenza (Influenza A and B).
Radonovich et al. (2019)	4689 healthcare personnel (HCP) (2243 HCP – assigned to N95 group and 2446 HCP assigned to surgical mask)	Randomized clinical trial	371 HCP in the N95 group and 417 HCP in the surgical mask group were positive for laboratory-confirmed respiratory illnesses.
Johnson et al. (2009)	Nine volunteers with confirmed influenza A or B virus infection	Quantitative assessment	Influenza virus was detected in all nine volunteers who did not wear a mask. Meanwhile, no influenza virus was found when participants wore either N95 or surgical masks.
MacIntyre et al. (2009)	145 symptomatic index cases and their household contacts	Randomized study	Overall, there was no significant difference in household contacts across intervention arms: control, surgical masks, or N95 respirators groups.
Cowling et al. (2010)	12 articles	Systematic review study	Limited evidence supports the effectiveness of face masks to

			reduce influenza virus transmission.
Gralton et al.(2010)	53 articles	Systematic review study	HCW who used an N95 or surgical mask during direct contact with patients were neither significantly protected nor significantly at risk for SARS compared with HCW who did not wear a mask.
Jefferson et al. (2020)	67 articles	Systematic review study	Surgical masks and N95 respirators were supportive measures offering the most consistent protection.
Ng et al. (2020)	41 HCW	Case study	85% of HCW wore surgical masks, while the rest wore N95 respirators. None of them acquired infection after being exposed during an aerosol-generating procedure to an infected patient.
Wang et al. (2020)	Six departments in Zhongnan Hospital of Wuhan University (Three high-risk departments and other three departments with lower risk)	Randomized clinical trial	None of the medical staff with N95 respirators in high-risk departments became infected, while 10 of 213 staff who were not wearing any masks in lower risk departments were confirmed as infected.
Wang et al. (2020)	Medical staff from Huangmei People's Hospital and Qichun People's Hospital	Randomized clinical trial	There were no infected cases among those who wore N95 respirators and frequently cleaned and disinfected hands.

SARS, severe acute respiratory syndrome; HCW, health care workers

4.0 CONCLUSION

In conclusion, it is important to know the mode of transmission to choose proper respiratory protection. The face masks provide physical barriers and most effectively limit short-distance transmission by direct or indirect contact and large droplet spread. At the same time, more comprehensive precautions is required to prevent infection at longer distances via airborne spread or small droplet particles. For airborne transmission diseases, surgical masks are less effective if worn by ill or infected people. However, a surgical mask prevents hand-to-face contact. Besides respiratory protection, it is also suggested that natural ventilation and hand hygiene were associated with fewer observed deaths during the virus pandemic, although there were many potential confounders.

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