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DUST POLLUTION IN CONSTRUCTION SITE

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Abstract:
Dust pollution that occurs in the environment is caused by poor air quality that is not monitored well in the construction industry during the construction process. The construction industry is a major source of pollution responsible for about 4% of particulate emission. This paper aims to study dust pollution in the construction industry in Malaysia, particularly looking at its impacts on human health and the methods used to control dust in the construction site. Data collected in this study were analyzed using triangulation method. The findings indicate that construction workers believed dust does give impact to body health problem and the most common method found to control dust is watering system. This study focus to impacts dust pollution in the construction site to human health and identify the methods that used to control the dust pollution in the construction site. It is hoped that the findings of this study would create awareness on the impact of dust and recommend a method that would best control dust in construction sites.

Keywords: Dust pollution; Health Problem; Control Dust ; Construction Site; Malaysia Environment

1.0 INTRODUCTION

Malaysia is one of the developing Asian countries that envisions to be a developed modern country by the year 2020. The construction industry is one of the focused areas in the recent Transformation National 2050, which is the government's mission for the country's transformation. One of the aspects of transformation is is the emergence of megacities with a population of over 10 millions due to the continued urbanization trend. With this transfromation, the environment should be of a major concern by the government to ensure that the air quality in Malaysia is not seriously affected that could be a health hazard. t There should be a balance between development and universal environment to avoid negative impacts that cause problems to humans especially in terms of air quality.

According to WHO (1999), dust consists of solid particles ranging in size from below 1 μm up to around 100 μm, which may be or become airborne, depending on their origin, physical characteristics and ambient conditions. Dust in general is a hazardous compound that is often found during on-site construction activities; the hazardous compounds are silica, asbestos, wood dust and synthetic mineral fibre. Besides this, solid particles of any kind inclusive of particulates and gases also indirectly contribute to air quality in the construction sites. According to Department of Environment (2010), the minister had highlighted "air impurities" which are substances that contribute to poor air quality . They include smoke soot, dust, ash cinders, grit, solid particles of any kind inclusive of particulates, gases, fumes, mist, odours and radioactive substance which are generated as a result of combustion of fuel and the like, or a result of the use of electricity as a heat source, or a result of synthesis, resolution or any other treatment. These substances, as stated by minister, are liable for adverse effects on human health or the living environment. As far as the environment at construction sites are concerned the presence of "dust" clearly contributes to pollution at on-site construction.

2.0 LITERATURE REVIEW

2.1 Dust Definition and Concept

Several definitions on dust pollution can be found in a number of research papers. According to WHO (1999), dust consists of solid particles ranging in size from below 1 µm up to around 100 µm. The SI unit to measure dust is micrometer or also commonly known as micron with a symbol "µm" (SI standard prefix "micro-" = 10−6) which may be or become airborne, depending on their origin, physical characteristics and ambient conditions. On the other hand, CIDB (2010), classifies the dust by size into three primary categories: respirable dust, inhalable dust and total dust.Respirable dust refers to those dust particles that are small enough to penetrate the upper respiratory and deep into the lungs. This dust is collected by using filtering media equipment that is able to filter a bed of sand, peat, shredded tires, foam, crushed glass, geo-textile fabric, crushed granite or other materials (Water Environment Federation. & American Society of Civil Engineers., 1998) that come from airborne dust during personal sampling which penetrates through a size selector with the following characteristics:

Table 1: Characteristics of respirable dust

Aerodynamic Diameter(micrometre) (unit density sphere)	**passing pre-selector (%)**
2	90
2.5	75
3.5	50
5.0	25
10	0

Inhalable dust is described as the fraction of dust with median aerodynamic diameter 10 µm which enters the body, but is trapped in the nose, throat, and upper respiratory tract.Overall, dust includes all airborne particles, regardless of their size or composition.

2.1.1 Source of dust pollution

The construction site has a lot of processes and activities.In a study by Zolfagharian et.al (2012), it was reported that that Malaysian construction activities have a 67.5%, 21.0% and 11.5% effect on the ecosystem, natural resources and the public respectively (as cited in Yusof & Iranmanesh, 2017). Dust can be generated from various sources of construction site activities, especially earthwork such as excavation work, besides other activities such as drilling, bulk material, transportation, loading and unloading, open-air material storage, concrete and mortar making, cut and fill operations Even movement of equipment also produces dust (Zuo et al. 2017).

So, there close related dust pollution in the construction site to the air quality in the environmental. Basically, there are four types of main processes involved during construction stage which are earthwork, structure work, services work and finishing work. However, the most major sources of dust pollution are earthwork and structure work This is becauese these types of works involve the use of many materials and equipment during the construction process. To conclude, sources of dust pollution originate from various construction procesess and activities that depend on equipment and materials used in the construction site. In other words, it is important for construction workers to identify the sources of hazardous particles of dust during construction activities for their own awareness and concern asto ensure those activities can be well monitored with good air condition.

Table 2 Sources of Dust and Type of Activities

CONSTRUCTION DUST PROFILES			
Type of activity	**Components of dust**	**Particle size**	**Particle count per cubic foot[1]**
Before construction	General IAQ	< 1 – 100 microns	20,000 – 30,000
Demolition	Gypsum, cement, silica, sawdust, general dust/dirt/ debris	< 1 – 200 microns	145,000 – 200,000
Framing	Sawdust, general dust/dirt/debris	20 – 200 microns	100,000 – 170,000
Sanding, cutting, grinding	Cement, sand, silica, wood fiber (sawdust)	0.05 – 150 microns	450,000 – 800,000
Drywall / plaster (demo, install, sanding)	Gypsum, silica, solids from coatings (i.e., resin, titanium dioxide, calcium carbonate, iron oxide, etc.)	< 1 – 200 microns	450,000 – 600,000
Flooring demo	Wood fibers, cement, sand, silica, asphalt, vinyl, cork, plastic, dirt	< 1 – 200 microns	150,000 – 200,000

(Source: Amanda & Sal, 2016)

2.2 The impacts Dust Pollution: Exposure and Disease

Dust pollution in construction site can cause a long-term impact on human health especially construction workers who work in open and close areas in the construction site. Normally workers are not the concerned and aware that they are breathing and inhaling air that contains hazardous particles while doing their jobs. More importantly, air pollution which is resultedt from construction sites do not only affect construction workers, but also it may spread throughout the workplace and pose potential nuisance to adjacent or nearby areas particularly where there are schools, hospitals or residential areas. The occupants in these places are exposed to serious health risk due to particle emission dust (Hansford, 2017). All of the types of dust contribute to air pollution, especially particle matter PM10 (dust) deposit, which affects mainly the upper respiratory tract, while fine and ultra-fine particles are able to reach lung alveoli (Kampa & Castanas, 2008).

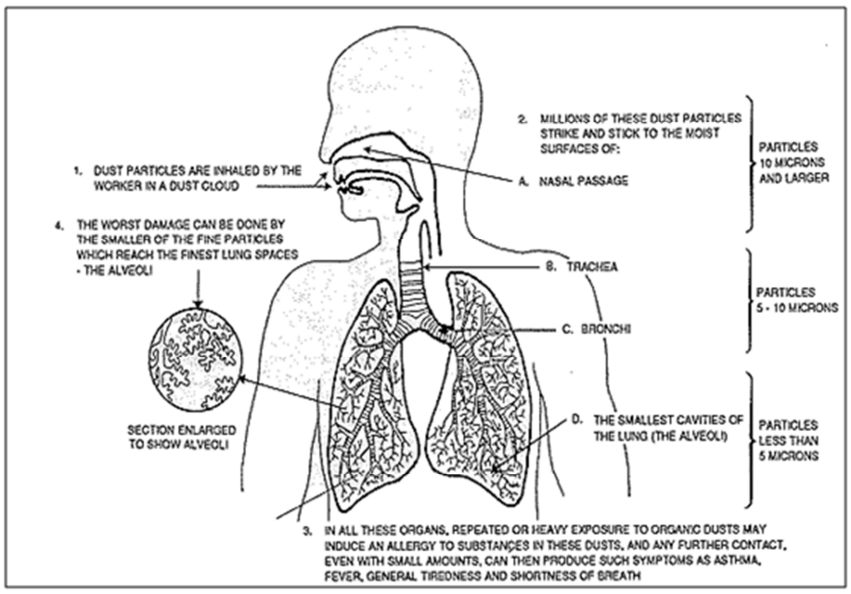


Figure 1: Respiratory System Affected by Particulate Matter

(Source: http://www.home-air-purifier-expert.com)

The respiratory system is one of the systems where the simultaneous process of breathing inhale and exhale a series of organs that are responsible for taking in oxygen and expelling carbon dioxide whereas lung is the main organthat is responsible to run the process It is therefore important for construction workers to take care of their lungs because the exposure to dust can causes diseases. Figure 1 shows the process of how dust can affect lungs and cause diseases; it starts with inhalation of dust particles by the workers either through nose or mouth Millions of these dust particles then strike and stick to the moist surface at nasal passage; the size of dust during this stage is 10 micron or larger. And only dust particles of about 5-10 micro can pass through trachea and bronchi..

Table 3: Examples of Health Effects

Type of dust	*Main health effect*	*Target organ*	*Fraction of interest*
Free crystalline silica	Silicosis (lung fibrosis); progressive and irreversible restrictive lung disease; also carcinogenic	Lungs, gas-exchange region, alveoli	Respirable fraction
Coal dust	Coal workers' pneumoconiosis; restrictive lung disease	Lungs; gas-exchange region; alveoli	Respirable fraction
Asbestos	Asbestosis; lung cancer; mesothelioma	Lungs; bronchial and gas-exchange region;	Thoracic and respirable fraction
Lead dust	Systemic intoxication (blood and central nervous system)	Through respiratory system into the bloodstream	Inhalable fraction
Manganese	Systemic intoxication (blood and central nervous system)	Through respiratory system into the bloodstream	Inhalable fraction
Wood dusts	Certain hard woods cause nasal cancer	Nasal airways	Inhalable fraction
Cotton dust	Byssinosis; obstructive lung disease	Lungs	Thoracic fraction
Dried sugar cane dust	Bagassosis (extrinsic allergic alveolitis)	Lungs	Respirable fraction
Cement dust	Dermatoses	Skin	Any particle size
Pentachlorophenol	Systemic poisoning	Through skin into blood stream	Any particle size

Dust realated diseases may become obvious only after a long term as that it is not easy to identify the diseases For example, mesothelioma that can be classified as the chronic effect of exposure to crocidolite appears only after a latency period of 40 years or more after the beginning of exposure. There are two health effects that can be classified which are acute effect and chronic effect. According to Construction Safety Council, (2012) acute effect is quickly seen usually after exposures to fairly high levels or

concentrations of hazardous substances. For example, fibreglass and cement dust can immediately cause itchiness and skin irritation The acute effects most frequently referred to are irritation, rashes and dry skin, dermatitis (acute), corrosivity, burns or dissolves skin tissue, sensitization , allergic reactions (anaphylactic shock), metal fume fever and Lethal Concentration (LC). The chronic effect usually develops slowly. For example, if you breathe small amounts of asbestos fibres, you won't even notice them. There are no acute effects. But if you inhale asbestos months after months, years after years, you greatly increase your chances of getting an asbestos disease, such as lung cancer. Other chronic effects include sieases such as cancer, asbestosis and silicosis (Maizura & Yusoff, 1996).

2.3 Dust Control and Method

Dust control can be defined as the key to preventing lung diseases associated with dusty working environment. It is done by preventing respirable or inhalable dust from being in the air (CIDB, 2010). Meanwhile, according to Construction Safety Council (2012), dust control by controlling exposures to occupational hazards is the fundamental method of protecting workers from hazardous particles.

Engineering controls are used to remove a hazard or place a barrier between the workers and the hazard. Means, control equipment must be implemented to reduce and maintain employee exposure to dust that poses the health hazard (Construction Safety Council, 2012). There are three control equipment that can be applied to control dust which are wet work, isolation and substitution. Wet work uses an element of water to minimize or reduce airborne dust in the clean up process, such as when sawing or drilling concrete or using masonry saws or drills that provide water to the blade. Second, isolation cabs of vehicles or machinery cutting or drilling through rock that might contain silica should be enclosed and sealed. Lastly, substitution means using other alternative material that does not contain hazardous chemicals, such as, silica sand or other substances containing more than 1% crystalline silica as abrasive blasting material (CIDB, 2010)

Administrative controls are changes in work procedures, such as, written safety policies, rules, supervision, schedulesand training with the goal of reducing the duration, frequency,and severity of exposure to hazardous chemicals or situations. There are six alternatives to control dust: administrative control, air monitoring, training, personal hygiene, restricted areas, provide medical examinations and report cases.

Personal protective equipment (PPE) is one of the last options if engineering and administrative control method does not provide adequate worker protection and reduce the permissible emission limits below recommended limits. Furthermore, PPE is the last line of defense for fighting occupational lung diseases. This method of control encourages workers to wear respiratory protection (refer table 2.4) for processes related to asbestos, lead and mineral dust that are approved by DOSH.

3.0 METHODOLOGY

The research methodology used in this study are qualitative and quantitative An interview session with a knowledgeable or competent person is conducted in order to get all the data needed. . This is to ensure data collected during the interview would be related to the real practicality in the construction site situation and surrounding. Next, for quantitative method, a questionnaire survey was distributed to get information and opinions about the current situation in terms of the impact of dust pollution towards health. The respondents are construction workers, including contractors and consultant team. This research only focused on the impacts of dust pollution in construction sites towards human health especially among construction workers in Malaysia and dust control methods at construction sites in Malaysia. The respondents for the questionnaire and interview were randomly selected randomly based on construction site areas, in Klang Valley.

4.0 ANALYSIS AND FINDINGS

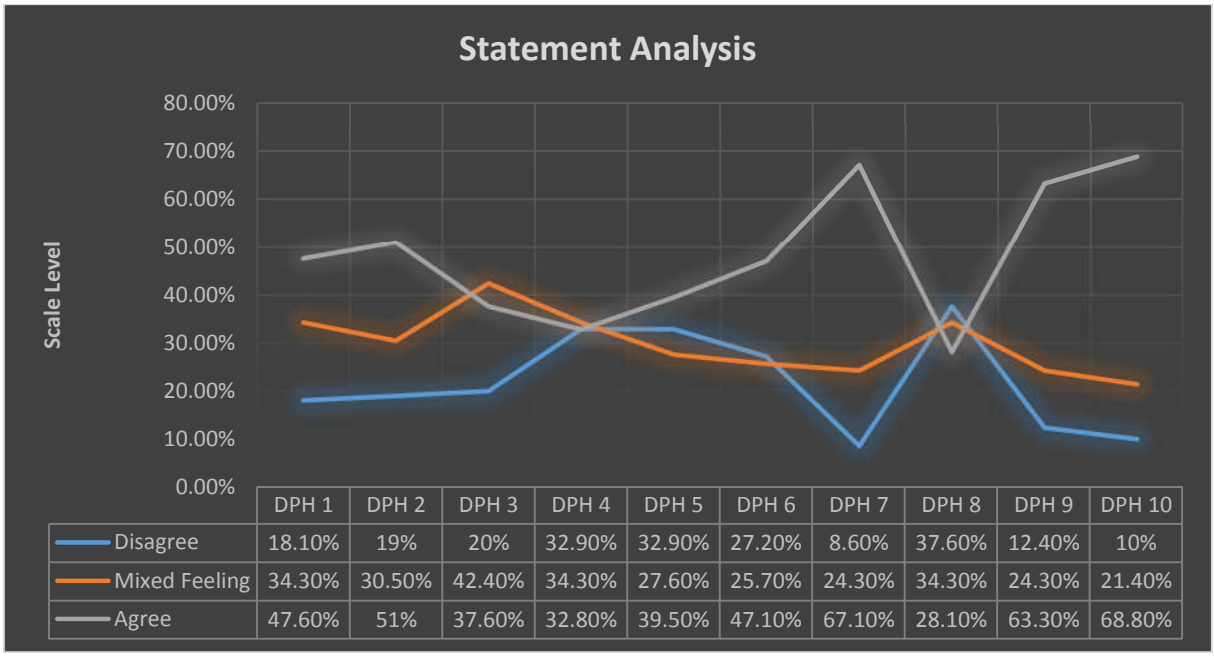
The demographic analysisis is summarized as per Table 4.

Table 4: Demographic Data analysis

No	Information of Respondents	Frequency	Percent (%)
1.	**Gender**		
	• Male	121	57.6
	• Female	89	42.4
2.	**Age**		
	• 19-25	146	69.5
	• 26-30	34	16.2
	• 31-55	16	7.6
	• 36-40	5	2.4
	• 40 <	9	4.3
3.	**Current Position**		
	• Contractor	135	64.3
	• Consultant	35	16.7
	• Other	40	19.0
4.	**Working Experience**		
	• 1-5	158	75.2
	• 6-10	38	18.1
	• 11-20	10	4.8
	• 20 <	4	1.9
5.	**Time Spend In Construction Site**		
	• 1/2 – 1 Hours	24	11.4
	• 2-4 Hours	39	18.6
	• 5-8 Hours	82	39.0
	• 9-12 Hours	52	24.8
	• 12 Hours And Above	13	6.2
6.	**Health Problems**		
	• Sinus/Resdung	34	16.2
	• Migraine	23	11.0
	• Asthma	8	3.8
	• High Blood	6	2.9
	• Low Blood	3	1.4
	• Skin Allergic	16	7.6
	• No	120	57.1
7.	**Smoker**		
	• Yes	49	23.3
	• No	160	76.2
8.	**Health Supplement Taken**		
	• Yes	50	23.8
	• No	160	76.2
9.	**See a Doctor (Month)**		
	• 1-2 Times	74	35.2
	• 3-4 Times	7	3.3
	• 4 Times And Above	1	5.0
	• No	128	61.0

Table 5: Statements Data analysis

No	Statement	Remarks
1	I have been suffering from cough and flu because of the dusty environment at the construction site.	DPH1
2	In my years of working, I had experienced of dizziness, headaches and tiredness after working hours.	DPH2
3	I do not feel comfortable while on construction site because of dust produced during construction activities.	DPH3
4	I have difficulty breathing while at the construction site due to the abundance of dust particles.	DPH4
5	I'm wearing a face mask at the construction site and while doing site works.	DPH5
6	I use a glove when doing site works, including when I touch and handle any construction materials in the construction site.	DPH6
7	After I am done with my work at the construction site, I wash my hands properly.	DPH7
8	I used to have itching and skin inflammation.	DPH8
9	During my break time, I will eat and drink away from the construction site.	DPH9
10	In my opinion, dust surrounding at the construction site gives impact to my body health.	DPH10



	DPH 1	DPH 2	DPH 3	DPH 4	DPH 5	DPH 6	DPH 7	DPH 8	DPH 9	DPH 10
Disagree	18.10%	19%	20%	32.90%	32.90%	27.20%	8.60%	37.60%	12.40%	10%
Mixed Feeling	34.30%	30.50%	42.40%	34.30%	27.60%	25.70%	24.30%	34.30%	24.30%	21.40%
Agree	47.60%	51%	37.60%	32.80%	39.50%	47.10%	67.10%	28.10%	63.30%	68.80%

Figure 2: Chart Line Data

The result and finding from Table 5 and Figure 2 show that the respondents had experience of dizziness, headachesand tiredness after working hours, which means they do agree that the dust environment at a construction site gives some impact on their health Besides that, 47.6% of the respondents indicated that they had suffered from a cough and flu because of the dusty environment at the construction site, while other respondents had mixed feelings about the statement. As for statement DPH 7, 67.1%, of the respondents washed their hand properly after doing work at the construction site. Because of that,the

impact that they will have an itching and skin inflammation is less, i.e. 37.6% had never experienced with itching and skin inflammation,whilethe rest of the respondents i.e. 34.3% of them said that they had mixed feeling with the statement. Statement DPH 7 which is related to statement DPH 6, shows that 47.1% of the respondednts used a glove when doing site works, such as touching and handling any construction materials in the construction site. The resultt of statement DPH 4which is about breating difficulty while at the construction site due to the abundance of dust conditions, showsthat 32.7% of the respondents agree that, they were suffering from dust environment and 34.3% had a mixed feeling about it. It's related with DPH 1 where 47.6% of the respondednts have been suffering from a cough and flu because of the dusty environment at the construction site This statement strongly supports statement DPH 3 where the 37.6% of the respondents agreed that they did not feel comfortable while on construction sites because of dust produced during construction activities. The tendency for construction workers to get health problems due to dust pollution at the construction site was less because of the percentage of statement DPH 9, where 67.1% of them eat and drink away from the construction site. Statement DPH 10 shows in general that the respondents agreed dust producedfrom construction site gives some impacts on their health A total of 68.8% agree with that statement.

Table 6: Interviewee Background Information and Organization

Respondents	Name	Gender	Age	Position	Experience	Company	Construction Site
1.	Rajan A/L Muthu	Male	19 -25	Safety And Health Officer	1-5	Fab Builders Sdn Bhd	Project Puncak 7
2.	Mohd Ramli Bin Nasir	Male	40>	Safety And Health Officer	6-10	Pesona Metro Sdn Bhd	I-City Project
3.	Fauziah Kamari	Female	31-35	Safety And Health Officer	6-10	Hab Construction Sdn Bhd	I-City Shah Alam Phase 4
4.	Shah Bella Mohammad	Female	26-30	Project Engineer	1-5	World Dbay Solution Sdn Bhd	Uitm Shah Alam
5.	Shamsyuri Bin Zen Omar	Male	40>	Safety And Health Officer	11-20	Conlay Construction Sdn Bhd	Jakel Development
6.	Amir Khairulanam Bin Azman	Male	19-25	Safety Site Supervisor	1-5	Johawaki Construction Sdn Bhd	Hospital Women And Children Shah Alam

Based on interviewees' experiences in the field constructions, the first activity that gives a major impact to human health among construction workers is related tocement material., This is because cement is one of the hazardous and common materials that is widely used in construction sites in Malaysia. as many buildings or infrastructure projects use cement for structure and finishing. Dust that is produced from cement materials is tiny and fine which is able to pass through or enter a human's body directly through air especially through the lung organ. The activities that involve cement materials are hacking process, concreting, tiles works, plastering, brickwork and demolition work. In Malaysia's constructions, workers or construction team are more exposed to dust comes from cement. Another activitiy that might give side effects to human health is wood dust This particle is categorised as organic and vegetable dust can originate in the same manner from a work process, for example, wood dust produced in sawing and sanding. Other earthwork activities also produce dust, such as, piling and lorry moving on construction sites, Based on information from a respondent, dump trucks and mixer lorries, that move around construction sites will also produce dust that originates from dry soil. The quantity of dust becomes major during dry season where there is no rain and low humidity.

In terms of health problems, usually, construction workers that are exposed to those activities above will cough, sneeze, have reddish eyes, tibi (tuberculosis) , itching and inflammation. This health problem is the acute effect that can be seen in the short term, but in the long term health problem such as lung cancer is not easy to trace; it might only be traceable within five to three years depending on individuals. According to the interviewee, Tibi is a disease with a long term effect that might occur due todust exposureTibi is a disease that normally attack foreign workers with a low antibody that work on construction sites. as they breathe in dust which leads to the activation of virus and bacteria on someone Moreover, there is no proper health record for construction workersas it is normal for construction sites in Malaysia to have workers who work for a short term period.

Health problem due to dust exposure gives a major effect to site process and activities. This is because awareness about health problems that come from construction sites especially dust is considered something that does not affect anything. Most construction workers still do not feel the impact of dust pollution at construction sites as observed by an experienced safety and health officer who manages a construction site. On the other hand, foreign workers who have been working in construction sites for about sux years or more have been suffering from lung cancer. This is because, there are no rotation works for hacking wall and working continuously would cause cement dust to attach on his lung organ through the breathing process.

Productivity is one of the effects that will be affected due tohealth problems. This is because the activity on construction sites might be delayed when some of the workers fall sick especially skiledl workers. The replacement may be one of the solutions but it will take time and the work produced by the new worker may not be the same as the old worker. Time taken to complete the work may usually take long when the workers do not feel comfortable with their environment and the condition of their body. Besides that, the probability of the project to be delayed due to health problems may contribute only five percent. This is because a delay in construction site comes from various factors; when productivity is slow, process and activities on construction sites are delayed as well since the planned work schedule is disturbed. Because of that, the cost to pay liquidated damaged might incur. As mentioned earlier, health problems maycontribute to minor effects to processes and activities on construction site

The first method that is widely used to control dust pollution in the construction sites in Malaysia is by using water as a medium to reduce dust from spreading to the air. One of the purposes to use this method is to reduce dust at earthwork activities which are related to machineries moving on construction sites that have the tendency to produce dust to the site surrounding. To reduce dust that comes from lorry and machineries, water is applied on dry soil by spraying water to the land or building water pond at the entrance of construction sites. Other examples of activities that use water are hacking, demolition works and cutting tiles. For the hacking works, before any hacking starts, water will be applied on the wall during hacking process. However, for demolition works, there are two methods used; first, by installing the barriers using canvas that has already been rubbed with oil or water with a suitable height depending on the structure and area of demolition. The problem that might occur is getting the source of water.Some the activities that producedust may be far away from water sources. Because this method dependency on sources of water is higher, the second method which is excavation of a trench around parameter of a building is used to ensure dust control after demolation.

Furthermore, for Iiternal and closed space, the mechanical system is applied. Construction sites normally use an exhaust fan to make a good ventilation process, for example, when workers do the installation in the basement. The exhaust fan is used to recycle air in that space so that workers will be not be too exposed to dust directly Moreover, administration control also is used to control dust in construction sites, for example, for cement mixing work, safety and health officer must allocate a specific place for it and put a signage warning and site board to warn that the place has exposure to dust because of cement mixing work. This method is called a centralized method to reduce dust on construction sites. For demolition work, such as an explosion of a tunnel at hilly and exposure area, notification will be made to nearby residents.

The final method to control dust is by using PPE, i.e. personal protect equipment. This is the last option that construction sites in Malaysia use to reduce direct contact of dust on construction workers

Safety and health officer would empathize wearinga mask before entering the construction site or doing any work that involves dust to reduce the impact on human health. However, based on the discussion, the type of face mask that construction workers wear is not specific to their work. They are given N95 type of face mask that is able to filter at least 95% of airborne particles of dust. All of these methods of dust control are commonly applied in construction sites in Malaysia. This is because these methods are cheaper and easy to manage compared to other methods that are used in other countries.

5.0 CONCLUSION

In summary, this research provides an exposure to the construction community in Malaysia, especially to those who involve directly in construction site environment. It is clear here that dust pollution in construction sites is a matter that should be taken seriously among the community and also should be controlled before it can harm the health of construction site workerssince it will give a serious effect to human health As mentioned earlier in the introduction, the purpose of this study was to investigatethe impacts of dust pollution in construction sites to human health and also to identify the methods that are used to control dust pollution in the construction sites in Malaysia. The major findings of the research are that the impacts of dust pollution in the construction site to human health give short and long terms implication to human body. In general, construction workers that are exposed to dust environment agree that their health problem may be caused of dust pollution. Meanwhile, this research paper also identifies the method that is used to control dust in construction sites in Malaysia.a conventional method that relies on water to reduce dust that comes from activities and processes in construction sites is normally used. Other that than, a mechanical method that is just limited to certain activities and level of exposure toward dust, is also used to control dustAdministration control and personal protection equipment such as wearing mask and centralized system are the best options to control dust.

Based on the findings and conclusion of the study, here are several recommendations to be considered. The construction workers should be given clear information and knowledge about implications that could happen to their health when they are too exposed towards dust environment in construction sites They also should do a medical checkup if they have acute symptoms such as cough or often fall sick. It is recommended thatconstruction sites should improve their method to control dust pollution by using a correct method according to the working condition. Face masks used should be suitable to the types of dust they are exposed to while doing work on site. Lastly, construction sites also should reduce dust by using a construction method that produces less dust such as IBS systems.

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