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Relating Air Quality in the Work Environment to Occupational Health Disease

Hussien Awad Alumar

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RELATING AIR QUALITY IN THE WORK ENVIRONMENT TO OCCUPATIONAL
HEALTH DISEASE

Relating Air Quality in the Work Environment to Occupational Health Disease

Thesis

Presented to the MSSS Graduate Committee

Of Embry-Riddle Aeronautical University

In Partial Fulfillment of the Requirements

For the Degree of

Master of Science in Safety Science

By

Hussien Awad Alumar, B.S. Electrical Engineering Technology

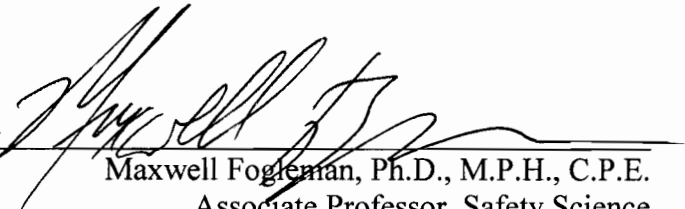
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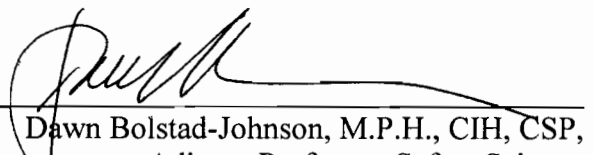
The graduate research project of *Hussien Awad Alumar*, in contribution to the Master of Science in Safety Science Department, Embry-Riddle Aeronautical University, under the title of *Relate Air Quality in Work Environments to Occupational Health Disease*, is approved as partial fulfillment of the Master of Science in Safety Science.

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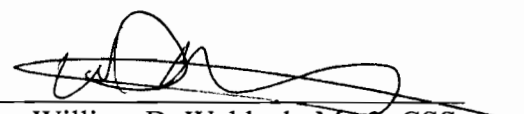
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Abstract

Comprehensive knowledge of the air pollutants effects on the human health generally is a crucial requirement in developing effective policies for reducing such adverse effects related to ambient air pollution. Such knowledge would be essential in helping various affected countries, including the less developed countries (LDCs), to develop effective regulatory frameworks for assessing and managing air quality in the workplaces. Developed and developing countries therefore need to develop effective techniques or strategies focused towards improving the workplace monitoring competence in diverse industrial environments. Such initiatives are essential in reducing or eliminating the industrial pollutants within the workplaces while also helping in developing effective working environment standards to preserve the workers' health. This research will therefore investigate the relationship between the quality of air in the working environment and the occupational health. The study particularly attempt to determine whether individuals working in the metal industries are at higher risks of air-related health effects as compared to those in other industries. A qualitative and quantitative method will apply, using both the primary and secondary data. A survey will be the major primary data collection tool while various cases will provide the secondary data (Reijula, 2008, p.8)

A questionnaire (Appendix A) was distributed in Jubai Industrial City, Saudi Arabia and completed by 178 study participants from three diverse industries: metal, petrochemical and building material. Chapter IV includes the analyzed data from the three groups of workers stratifying those gathered data for two vital aspects that might impact on the result by being confounders which are smoking habits and age. A retrospective person time cohort study took place for assessing the relative risk of air pollution exposure to the workers' occupational health problems such as respiratory disease, occupational asthma, and scar tissue.

Chapter I

Introduction

Increased occupational health, safety and hygiene awareness in the recent years have led to major improvements of the working conditions while also minimizing the exposure of workers to multiple toxic substances in various industries. However, substantial hazards remain high with the number of the occupational disease cases generated from hazardous exposures. New occupational health cases are inevitable if countries fail to further improvements. New challenges moreover are emerging particularly due to the increased energy development, electronics, biotechnology, chemicals and other industrial activities. There is a rising tendency in developing ambient, biological limits while also developing strategies for their implementation, thus preventing the health damage generated from toxic substances exposures. The monitoring aspects are inclusive of information provision to help in compliance with the standards, validating the compliance plus information accumulation to help in revising the standards in future. Analytical methods can apply to studying the workplace monitoring in relation to refining, mining and the metal working industries, thus offering viable information in assessing the probable negative health effects. Toxic, heavy metals and the trace elements, which may have detrimental effects, are determined through the airborne particulates. The high concentrations toxic substances in specific metals and their related compounds are observable within the workplace environment in general (Dockery, 2009, p.258).

Problem Statement

The research will discuss the relationship between environmental issues and the occupational health. It will focus in the workplace that appears to have some detrimental effects on the occupational health of the workers in Saudi Arabia. Examining this specific research problem will be essential considering that the work-environment is a crucial element in the daily life of the workers. The quality of the environment could play a critical role in the occupational health of workers. An employee operating within the metal industries; for example, could suffer greater risks of respiratory diseases compared to individuals working in building materials and chemical industries.

Study Objectives

The objectives of this study will be:

- To demonstrate effects that the work environment has on the health of workers
- To evaluate the relationship between air quality and occupational health
- To evaluate whether the metal industry has higher risk of occupational diseases compared to building materials and petrochemical industries

Definition of Terms:

Occupational health. Occupational health (OH) relates to the work effects on the health of an individual and the health effects on work. OH plays a critical role in assisting employers to care and understand their employees' needs (Rosenstock, L., Cullen, M. & Fingerhut, M., 2008, p.1127). In consequence, this reduces absence from work due to sickness so that a company can optimize on its staff productivity and performance. It is a fundamental element of an organization's human resource (HR) policy allowing employers in complying with the Health and Safety laws while also enduring effective management of risks related to the workplace. Other essential areas incorporated in OH involve the provision of advice to organizations on medical and rehabilitation intervention programs, ill-health retirement matters, disability adjustments and the efficient management of the current work-related health issues.

Rosenstock et al (2008, p.1128) further observes that workers across the globe regardless of their social, physical, political or economic environments encounter virtually similar forms of workplace hazards. Such hazards conventionally operate under four major categories including biological, chemical, psychosocial and physical. However, more than 80% of the workforce worldwide residing in the developing nations disproportionately participates in the global burden related to occupational injury and diseases. A number of classic occupational illnesses including lead and silicosis poisoning, which have been successfully eradicated within the industrial nations have remained an endemic in other regions of the world. Regardless of whether this high and preventable ill-health burden workers encounter daily within the developing world generates from inattention, ignorance or deliberate intentions, evidences show that work-related health status/conditions (occupational health) can considerably reduce at an affordable cost.

Environmental Engineering-Environmental Engineering (EI) involves the application of chemistry and biological principles in developing solutions for environmental problems. Such may include activities such as recycling, pollution control, public health issues and waste disposal. MPMWI (n.d, p.1) noted that environmental experts/professionals carry out hazardous-waste management researches through which they analyze the importance of hazards, provide assessment concerning the hazard's treatment/containment plus the development of controls to prevent mishaps. This field incorporates both the local and global environmental issues. Studies carried out in this field try to reduce the effects of global warming, acid rain, ozone depletion and automobile emissions (Germany, 2003, p.13).

Air Pollution; Indoor & Outdoor Air Pollutants-Another term for air pollution is atmospheric pollution. WHO defines air pollution as the material presence in air, that are harmful to living things anytime they come into contact with the threshold concentration levels of such materials. Foreign bodies such as gases and bodies serve as some of the air pollutants. Significant pollutants relate to sulfur dioxide, vapors, fluorides and hydrogen sulfide. Chemical firms that pollute the air are present within refineries, ceramics, paper mills, glass manufacture, clay and fertilizers. SAPRD (2012, p.1) observed that chemical processing is a significant contributor to air pollution. Air pollutants that take place naturally involve the spores, pollen, volcanic gas and marsh whereby in urban areas it results mostly from the automobiles, accounting for about three quarter of air and noise pollution.

In some regions where industries are in high concentration could lead to air pollution. Air pollution sources are many and they could be mobile, industrial or stationary (Hays, 2008, p.1). Stationary combustion sources could relate to activities such as fuel burning while mobile combustion sources could comprise of automobiles, aircrafts and locomotives and industrial air

pollution sources could incorporate crushing, mixing and grinding. Air pollution could take two major forms including outdoor and indoor air pollution. They generate substantial health challenges across the world. Indoor air pollution (IAP) is the air pollution that generates from coal and biomass fuel effects, affecting approximately 80% of the low-income nations within South Asia and Africa.

IAP generated from the solid fuel use plus the ambient pollution of air have huge numbers of the hazardous pollutants. This kind of pollution has detrimental effects on birth/pregnancy outcomes and child mortality particularly due to respiratory infections. On the contrary outdoor air pollution (OAP) results from small particles and the ground ozone level generated from smoke, car exhaust, factory emissions and road dust. According to Germany (2003, p.15), the quality of outdoor air similarly suffers effects caused by pollen from crops, plants and weeds. Particle form of air pollution is could be high at any moment of the year with its level rising next to busy roads or areas where there are wood burning activities. Once inhaled, the outdoor air pollutants aggravate the lungs and precipitate as coughing, chest pain, dizziness, digestive issues, sneezing, lethargy, watery effects, breath shortness and throat irritation, and OAP could worsen the chronic respiratory ailments including asthma.

Primary Air Pollutants and their Subsequent Effects

Lead:Reijula (2008, p.84) defined this as a metal that is responsible for retarded intellectual development and seriously affects the behavior patterns. At high levels, lead raises miscarriage cases among women, increases blood pressure and impairs the renal functioning. It is also common to have siderosis when inhaling iron dust or fume which usually exist in metal factories.

Siderosis: is a pneumoconiosis disease that affects the lungs when inhaling iron dust or fume.

Particulate Matter (PM): Most of the significant air pollution's health effects within Asia relate to exposures to the airborne particulate matter that mostly causes the premature death among people due to lung and heart diseases, asthma, chronic bronchitis in addition to other types of respiratory illnesses (Reijula, 2008, p.84). The effect of PM increases co-currently with the decreasing particle size and majority of researches have been stressing on particles smaller than 2.5microns or 0.1microns (ultrafine).

Ozone: This is what causes the photochemical smog. It is associated with the decrements in lung functioning, asthma attacks plus other respiratory diseases. Ozone does not omit directly but forms in the atmosphere via photochemical reaction of nitrogen oxides and the reactive hydrocarbons (Reijula, 2008, p.84). Ozone also has low water solubility which makes it a lower respiratory disease because low soluble gases can pass through the alveolar lining into blood streams to target the respective targeted organs.

Oxides of Sulfur:SO_x is responsible for causing changes in the functioning of the lungs among people suffering from asthma while exacerbating respiratory symptoms among the sensitive individuals. Reijula (2008, p. 84) added that it also contributes to the acid rain plus the small particles formation via the atmospheric reactions known as secondary particles thus increasing PM load subsequently.

Oxides of Nitrogen:NO_x affects the lung functioning of the asthmatic people while also contributing to the acid rain and the secondary particulate formation. It is also a precursor of the ground-level ozone (Reijula, 2008, p.84).

Carbon monoxide: CO gas inhibits the blood capacity in carrying oxygen to body tissues and organs. According to Reijula (2008, p.84), people suffering from chronic heart diseases could experience chest pains particularly when there are high levels of CO. At extremely high levels, CO could impair vision, learning ability and manual dexterity.

Chapter II

Literature Review

Evaluation of Past Studies

Operations of various industries including metal, chemical and building materials industries introduce common pollutants in the environment. Besides affecting the surrounding community, the activities of these industries similarly affect the health of their workers due to constant exposure to poor environmental conditions. According to (Rosenstock et al 2008, p.1130), environmental hazards could include the air pollution generated from the chemical presence within the outdoor or indoor air environments. Although various researches have studied this issue, the studies have not been adequate to evaluate the long-term health impacts of air pollution comprehensively. Human health reactions towards the multiple psychological and physical factors of indoor environment are increasingly personal, well defined and complex. The general knowledge; however, indicates a qualitative relationship existing between air pollutants exposure and the health effects of workers.

Various studies in Saudi Arabia (Jubail Industrial City) and other Western countries have taken place to compare environmental problems to the occupational health. However, similar data is lacking within the developing nations. Such studies within the developed countries aim to prove that the environmental quality has a strong influence in the daily life of workers plus its possible effects on their occupational health. In Western nations, about 25% of all the avoidable diseases are generated from environmental factors. Suggesting there is a relationship between environmental conditions and human health. Various countries therefore have to increase their ability to enhance and safeguard human health with better management of the environmental in order to regulate the 25% preventable diseases. Although western nations seems to have done

quite a commendable job in regulating the largest percentage of the environmental problems, there is still much required in decreasing the diseases burden in developing nations populations.

In a different research by the National Institute of Environmental and Health Sciences (NIEHS), results showed that lengthy exposure of workers to air pollutants raises the respiratory diseases risks including asthma, chronic obstructive pulmonary ailments, allergies and lung cancer. World Health Organization (WHO) has been working hand-in-hand with the Saudi Arabian Ministry of Health in the 'Global Burden of Disease' (GBD). One major aim of this partnership is the management of the country's environmental health matters. The government of Saudi Arabia will have to improve their efforts of enhancing healthier workplace environments. Statistics show that Saudi Arabia's Upper Respiratory Diseases (URD) constitutes 27.1% of all illnesses occurring in the work place.

Occupational health in Saudi Arabia within the industrial activities field tackles injuries related to work, disease prevention, workplace environmental monitoring particularly in the high-risk industries including the petrochemical, metallic, textile and plastic industries. Preventive measure linked to radiation and measurement of exposure doses towards radiation among the radioactive isotopes exposed to health facilities workers is inclusive. According to Saudi Arabian Ministry of Health statistics, 22.9% of the illnesses taking place in the workplaces were within the metallic industry. The food sector held 16.5% while the building material and printing industry held a 10.1% each, of the work-related diseases. Chemical and plastic industry had the lowest percentage of disease cases at about 4.2% (HSYB, 2009, p.85).

Another study by NIEHS in the US discovered a relationship between air pollution and the mortality. The research studied residents of six cities in US (Northeastern & Midwestern), assessing the impacts of ordinary air pollutants on risks of cardiovascular illnesses. Findings on

this study indicated that people residing in increasingly polluted cities suffered higher hospitalization risks plus premature deaths due to lung-cancer or other respiratory ailments as compared individuals living in other less polluted cities.

In Australia, incidences of such health effects linked to the work-environment apparently have received minimal systematic investigation. Nevertheless, a number of studies indicated that the mechanically ventilated workplace buildings, in complying with the present ventilation procedures or the occupants, regularly hold limited experience on outdoor and indoor air. Individuals exposed to poor air quality are vulnerable to various forms of ailments ranging from allergic reactions, asthma and cancer risks among others (Germany 2003, p.3). Although some of the health effects could show-up years later following an exposure to the pollutants, others will emerge long after repeated exposure periods. Such long-term health effects comprising of the respiratory and cancer illnesses could have adverse consequences, sometimes becoming fatal.

According to estimates of the WHO, about 6.6million deaths and 164million disabilities were because of environmental risks in Asia Pacific. Environmental risks include factors such as sanitation/hygiene, unsafe water, indoor/outdoor air pollution, wastes, chemicals, recreational environment, noise, radiation and climate, among others. A comprehensive study of some selected main environmental and occupational risks showed that the combined urban air pollution, sanitation/hygiene, lead exposure, climatic change and the indoor smoke generating from solid fuels were responsible for about 2.9million deaths. Occupational risks including the factors causing injuries, carcinogens, airborne particulates, noise/ergonomic stressors led to approximately 430,000deaths in Asia Pacific region (ETHAP, 2010, p.78).

Following the rapid industrialization and urbanization, the entire outdoor air quality especially in the urban areas has been deteriorating for the last 40years. While majority of the

developed nations have improved the quality of their air in the recent years, the developing nations are still struggling with this challenge/problem (Germany, 2003, p.13). In Asia Pacific for example, WHO estimates state that about 500,000 lives are lost annually, attributed to the urban air pollution and about 97% of the deaths occurring within the less developed countries (LDCs). In this region, indoor air pollution tends to present even greater challenges because of the extensive use of the solid fuels including dung, wood, charcoal, coal and agricultural residues. Application of this form of fuel is largely common within the rural areas or the poor urban regions (Dockery, 2009, p.259).

Various studies by the America Cancer Society (ACS) and Health Effects Institute (HEI) also showed the long-term effects of air pollution to human health. The study related the increased mortality to the increased cardiovascular diseases. ACS study in particular discovered all causes of lung-cancer and cardiovascular deaths linked to the risks generated by air pollution (Germany, 2003, p. 10). A research by Adventist Health and Smog (AHSMOG) found out that considerable effects of air pollution on the non-malignant respiratory health issues and deaths in women and men plus the cancer illnesses linked to their surrounding environment rather than the smoking habits.

The study indicated that the health effects were much stronger when assessed in relation to air pollution as compared to other sources such as smoking. The traffic-related air pollution increasingly related to the cardio-pulmonary health effects and deaths especially for people residing near the main roads (Germany 2003, p.11). Several other studies have evaluated the relationship between lung cancer and air pollution. One Swedish study indicated the existence of a relationship between this health effect and motor vehicle emissions that may involve the diesel

exhaust, although diesel exhaust is not yet a proven human carcinogen according to the Agency for Research on Cancer (IARC).

Another study revealed a relationship between the quality of the indoor air and safety and occupational health of workers. According to this study, occupational health professionals should always address the indoor air problems during their evaluation of health risks related to the work environment. High-quality indoor environment contains valuable effects over the employees' health, productivity level in offices and the social atmosphere within the workplace. According to the WHO, about 30% of the workers operating in renovated or new buildings reported multiple complaints related to the work environment. This study indicated that indoor air-related challenges are typically common. One among three workers moreover consistently complains over issues linked to the indoor environment while one among five employees held indoor-air related symptoms. Poor indoor environment quality could result to work-related diseases and symptoms while high quality promotes the work performance, welfare and productivity of the workers (Reijula 2008, p.83).

Societal costs generated from the urban air pollution comprise the human health damage, reduced visibility, increased greenhouse gas emissions and damage to vegetation and buildings. The grievance consequences of such level of air pollution include the premature morbidity and mortality. Damaged human health serves as an effective core indicator of air pollution adversity. The classical or primary air pollutants are inclusive of the nitrogen dioxide (NO₂), sulfur dioxide (SO₂), Ozone (O₃), particulate matter (PM), lead and carbon dioxide (CO₂). Health-related standards for ambient air quality are generally set initially to regulate the classical pollutants and thereafter they apply in establishing the degree of air pollution problem (ETHAP, 2010, p.84).

Other recent studies have been in constant attempts of quantifying the health effects generated by the ambient air pollution. The Global Burden of Disease (GBD) through their WHO project estimated that approximately 6.4million years of the healthy lives are lost out of the lengthy exposure to ambient particulate matter. It is for this reason that WHO updated the Air Quality Guidelines (AQG) for Europe particularly to facilitate comprehensive details concerning the influences of various air pollutants exposure on the human health. According to (Germany 2003, p.1), the primary purpose of this initiative was to offer a platform over which the country could safeguard the human health from the air pollution effects. Such guidelines particularly aimed at providing the authorities with information and guidance on how to make the risk management decisions. European Union (EU) for example applied the WHO guidelines as the foundation to set-up binding limit values for air quality and targets for a number of pollutants in all the EU countries. All this indicates that air pollution is a detrimental factor in the health of humans even in the workplaces where people suffer exposures to high level of polluted air particularly within the metal industries (Germany, 2003, p.1).

In another study, it was discovered that an estimate of all the preventable ailments (about 25%) have their roots on the environmental factors. Therefore, Environmental conditions and human health closely interrelate. Airborne contaminants generate in a gaseous form (vapors and gases) or in form of aerosols. Aerosols could exist in form of airborne sprays, dusts, smokes, mists and fumes in metallic, building material and petrochemical industries. Within an occupational setting, all such forms could be significant since they relate to a broad range of the occupational diseases.

Germany (2003, p.6) observed that airborne dusts particularly in the building material industry for instance are popular for their broad effects on occupational lung ailments including

pneumoconiosis and the systemic intoxications like lead poisoning particularly when the exposure level is high. Recent studies seem to be diverting their attention on other dust-related illnesses including asthma, cancer, irritation and allergic alveoli in addition to the non-respiratory diseases that may occur at lower levels of exposure to pollution. Dusts could generate from the work-related processes or could take place naturally such as the volcanic ashes, pollens and sandstones.

Although in the occupational hygiene the airborne dust applies as the acceptable term, the atmospheric environment refers to it as the suspended particulate matter (SPM). Aerodynamic airborne particles behaviors are critical across all control and measurement areas of the dust exposure (Germany, 2003, p.11). Responsible entities should commit in the reduction of risks generated by such diseases through generating better regulation of dust pollutants within the workplaces. Various countries therefore have been aggressive in increasing their capability in promoting and safeguarding the human health by effective management of the environment. Such initiatives will be effective in helping various regions to minimize or regulate the approximated 25% of the avoidable sicknesses that generate from the environmental conditions.

Most countries today are devising new strategies and techniques to tackle the indoor environment challenges through ensuring the working places are conducive (Rosenstock et al, 2008, p.1131). Air pollutants from the steel and iron making company operations have historically been associated with health and environmental hazards. Such pollutants could involve the gaseous substances including nitrogen dioxide, sulfur dioxide and carbon monoxide. Citing the case of the 'National Steel Industrial Group Beam Rolling Mills Factory' in Iran for example, it has two major production lines comprising line 630 and 650, operating under different beam production capacities with high ability to produce diverse kind of beams.

(Gadgil, A. et al. 2009, p.220) presented a study conducted on this factory in 2005 that indicated a close relationship between occupational health and air pollution.

Working in this steel and iron factory was exposing workers to a broad range of pollutants. According to (Gadgil et al 2009, p.23) however, the exposure level depends on the specific process, materials used and the efficiency of the control/monitoring measures. Experts determine such adverse effects of pollutants based on pollutant propensity, physical state, duration/intensity of the exposure, individual sensitivity and the accumulation degree of the pollutant within a person's body. Some effects are instant while others take quite long (years or decades) to develop. Changes on equipment and processes in addition to the improvement actions in maintaining exposures to toxic substances levels low have been effective in the minimization of occupational health risks to workers.

Iran National Steel Industrial Group (INSIG) operates among the largest casting and melting firms in Iran. Consumption of energy, raw materials and water is quite high leading to considerable emission volumes of air pollutants, both outdoors and indoors. According to (Gadgil et al 2009, p.23), potential health effects rely on the number of particles within the respirable range, dust chemical composition, exposure duration and exposure concentration. In studying this factory, the researchers' main objective was to determine the mean value for respirable particulate matter (RPM) concentrations within their two production lines (production line 630 & 650). The study also aimed to evaluate relative pollution risk over the health condition of the exposed and the non-exposed worker groups.

Findings from this study showed a direct relationship between indoor air pollution and the increasing risk of the cardiovascular illnesses, chest tightness, retention challenges and cough. According to (Gadgil et al 2009, p.24), unacceptable work conditions that are noisy, unhygienic

and dark could lead to an increased risk to health problems. Other unsafe behaviors that can result in negative occupational health effects while working in an industry could involve failure to use the respiratory mask. Results of this study indicated the need for improving the work conditions to facilitate workers well-being. (Gadgil et al 2009, p.24) recommended that industries should improve their awareness training programs among their workers in regards to the use of safety equipment as one of the preventive measures. Equipment for all the workstations need be stored effectively and the firms operating in such industries should periodically carry out medical inspections on workers operating as a compulsory management program to promote the workers well-being.

In an analysis of various air-pollution related studies in China, (Hays 2008, p.1) stated that the Chinese environmental protection ministry in 2010 indicated that approximately a third of its 113 cities studied were failing to comply with the national air standards in 2009. World Bank's estimates revealed that among the 20 cities having the worst air across the globe, 16 cities are in China. Chinese government sources similarly indicate that around one fifth of the country's urban areas rate to have the greatest air pollution. Majority of these places have smells of leaded gasoline and high-sulfur coal. The Chinese smog-filled cities are comprised of the metal smelters, heavy industry and coal-fired power firms whose operations are highly critical in maintaining the speedily developing economy even as the tons of metals, carbon and gases dust into the air.

The study conducted by the World Bank indicated that only one percent of the Chinese city dwellers breath safe air based on the European Union Standards (EUS). Another study by the WHO made an estimation of airborne suspended particulates amount in Northern China to be about 20 times worse as compared to what the organization considers safe. Cement firms are

among the largest air pollutants in China. This is because the plants require huge amounts of energy (coal) to heat every ton of cement (Hays 2008, p.1). Converting limestone plus other materials to make an intermediate cement form is a production process that generates vast amounts of heat, which is released to the air. Such air pollution in such plants has detrimental effects on Chinese residents inclusive of the workers operating in such firms. One New York resident after visiting China confessed his agony of living with the Beijing's air pollution. The individual stated,

“After four years in Beijing, I've learned how to gauge the pollution before I open the curtains; by dawn on the smoggiest days, the lungs ache. The city government does not dwell on the details; its daily air-quality measurement does not even tally the tiniest particles of pollution, which are the most damaging to the respiratory system. Last year, the U.S. Embassy installed an air monitor on the roof of one of its buildings, and every hour it posts the results to a Twitter feed, with a score ranging from 1, which is the cleanest air, to 500, the dirtiest. American cities consider anything above 100 to be unhealthy. The rare times in which an American city has scored above 300 have been in the midst of forest fires. In these cases, the government puts out public-health notices warning that the air is “hazardous” and that “everyone should avoid all physical activity outdoors” (Hays, 2008, p.1).

Chinese health problems relating to air pollution are grave such that across the world, the country loses the largest number of people through death. Based on WHO statistics, approximately 700,000 Chinese die every year due to air pollution effects. Chinese government estimates also notes that about 300,000 Chinese die annually due to ambient pollution in the air after suffering lung cancer and heart diseases (Hays (2008, par. 7). The government report

further adds that 110,000 extra deaths results from diseases related to the indoor air pollution, especially from poorly ventilated coal and wood stoves or toxic fumes generating the shoddy construction materials. According to the Chinese government, improving the quality of air to considerable levels could help in reducing the air-related illnesses among both workers and citizens at large. One Washington citizen, after living in Beijing for a number of years, noted that when his family relocated to Los Angeles, the frequent chronic chest infections and asthma attacks on his son stopped. This is clear evidence that the poor air quality in China was a contributing factor to his son's health condition.

According to Hays (2008, par. 14), all air pollution types are more than 10times damaging to an individual's health as compared to all kinds of water pollution. Reports from WHO indicate that about 300000 to 350000 persons die from outdoor air-related illnesses and 300,000 from indoor-air related diseases (Hays, 2008, par.11). Air pollution depresses the functioning of the lungs to the otherwise healthy individuals. Poor air condition in China furthermore links to the country's increased cases of people suffering from lung cancer. For the last five years, (Hays 2008, par 16) observed that this disease has claimed between 18.5% to 34% lives for every 100,000persons. A number of respiratory ailments similarly relate to air pollution. People working/living within the factories environments suffer about 5% asthma rate (causing about 26% deaths in China and 2% or 3% in the US). Majority of people working or living in Shanghai or Beijing suffer hacking coughs while within the rural areas, respiratory disease is the leading killer. However, it is difficult to demarcate or determine how many disease cases resulted from air pollution and those generating from other causes such as smoking.

Another research by the Coordinate Research Project (CRP) assessed the levels of health effects related to the airborne particulate matter in metal refining, mining and the metal working

industries, applying the nuclear plus the related analytical methods (IAEA, 2008, p.3). The project involved 11 countries, having participants from Asia, Africa, South America and Europe. In every participating country, workers generated from metalworking, metal refining or mining industries served as the study group. The findings/data produced from this research supplemented the already existing data, although it improved the understanding of the workplace pollution levels plus their subsequent effects on human health. The study confirmed the existence of some traces of toxic elements within the fluids and body tissues of the participants. New knowledge developed on the relationship between occupational exposure and biological response magnitude. Knowledge generated from occupational exposures and their related health impacts supported the National Authorities within the engaged countries in formulating regulations and codes to regulate the occupational exposures within the concerned industries (IAEA, 2008, p.12).

The Pacific region's case of poor air quality is a reflection of the poor infrastructures and weak policies in most countries (ETHAP, 2010, p.87). Although the SO₂ level has subsidized in most urban regions of Asia in the recent years for example with some reduction of NO₂ and PM, the levels are still considerably high in majority of the cities. The various studies conducted in Asia regarding the health effects linked to air pollution are still insufficient although they have substantially increased in the last 10 years. According to the multi-studies carried out in this region, a 10 microgram increase in PM increased the health/death effects by 0.5%. The results were in support of similar study-findings in the European and North America multi-city researches.

A study on the quality of air in Nepal indicated a declining trend particularly within the urban regions due to increasing number of industries and vehicles in the area. Nepal environmental condition in 2001 showed an increase in respiratory diseases from 10.9% in 1996

to 11.6% in 1998 of the total outpatient visits. According to (Rosenstock et al 2008, p.1127), acute respiratory infection was responsible for about 30% of the total deaths in Nepal. A considerable portion of Nepal's population in the urban and rural areas suffers from bronchitis generated from domestic smoke. The challenge moreover seems to be severe in large urban areas including Kathmandu, Biratnagar, Pokhara and Birgunj. Majority of the urban residents residing on the mountain regions appear to have higher vulnerability to respiratory illnesses due to their exposure to high ambient air pollution levels and poor air quality because of the wood burning activities within the poorly ventilated houses. Constant findings across many cities, including those within the developing world that have diverse populations and varying particle features hold firmly that health benefits indeed generate following subsequent minimization of PM levels.

Evaluation of the health benefits linked to minimizing air pollution has made immeasurable progress in the last 10-15years (ETHAP, 2010, p. 89). Estimates for health effects of air pollution generally generate from the epidemiological studies, whose design aims to determine relationships (concentration-response functions) between air pollution and health effects on the human populations, especially workers. Constant findings across many countries/cities including the LDCs, which have diverse populations plus a range of particle features strongly indicate that indeed health benefits generate from the reduction of air pollution. Developing scientific evidence highlights the increasing damage of air pollution with the decreasing particle diameter. According to this evidence, larger PM particles solely deposit exclusively on the throat and nose while smaller particles can reach the lower regions of the lungs. Intermediary size ranges however are deposited in-between the two extremes of the respiratory tract.

A considerable statistical relationship is evident between the ambient PM concentration and the adverse health effects while the most recent studies have indicated an even stronger relation between health results and the size of the PM particles. Reijula (2008, p.93) stated that current estimates by WHO on respiratory diseases have attributed such diseases to the indoor air pollution including the use of the solid fuels. Indoor-air pollution associates with many diseases including pneumonia and the acute lower respiratory infection. Chronic obstructive pulmonary disease has its root cause as the exposure to the indoor smoke generating from solid fuel burning, mostly common in East Asia countries, China, South Asia and India. Some of such health effects of air pollution have become fatal such that China suffers approximately 15,000 deaths of its population annually. Asia Pacific region similarly lost about 1.1 million of its population through deaths caused by such air pollution in the year 2000 while most of the deaths were evident within the developing countries of that region (ETHAP, 2010, p.90).

Air pollution is truly a challenging issue in many countries across the globe. Air pollution generating from one country/city could affect other locales including the sandstorms and dust. In North-East Asia, the haze triggered by the fabricated fires within Sumatra and Borneo within South-East Asia or even the brown clouds within Southeast and South Asia. (ETHAP 2010, p.82) argued that although the health effects of such trans-boundary air pollution occurrences have not received adequate study, there was an observation of high correlation between health impacts and haze in Sarawak, Kuching and Malaysia in 1997. Considering its trans-boundary nature, haze annual occurrences estimation indicates that about 20 million people are at the risk of respiratory diseases.

Most vulnerable nations include those within the vicinity inclusive of Malaysia, Indonesia, Thailand and Singapore. Other distant countries including Maldives could also

experience transient air pollution because of the haze effects. In majority of Asia Pacific countries particularly the LDCs, there is a dire need in improving the human resources and the institutional capacity in prioritizing the analysis of the health effects linked to air quality challenges. Generating and implementing air-pollution health effects database is apparently a matter of urgency particular to guide the policy-makers in effectively managing such problems (ETHAP, 2010, p.94).

In order to manage the air quality in Europe for instance, as a way of preventing the deteriorating health of workers, world health organization agreed with the European Commission to facilitate efforts of providing Clean Air for Europe(CAFE) programs. The partnership helped the Commission in conducting periodic, systematic and scientifically independent reviews. Scientific Advisory Committee (SAC) comprising of the independent experts within the field of health effects generating from the air pollution was developed by WHO, to channel the review process. The Commission Committee was the overseer of the review process and offered advice on its methodology and scope (IAEA, 2008, p.111).

The ultimate goal of any clean air policy in a country is the development of strategies that can help in reducing adverse effects risks on peoples' health affected by the ambient pollution of air. Following the susceptible population's presence plus their subsequent ability in detecting health effects of poor quality of air supply, setting-up standards of protecting the public health is no longer essential. Risk reduction strategies however continue to be effective tools in the promotion of public health. Strategy development of that kind however demands for adequate qualitative and quantitative knowledge regarding the most applicable adverse effects (SAPRD, 2012, p.21). Considering the many negative health effects air pollution is having on people today

across the world, majority of countries are devising and adopting various strategies of regulating/reducing air pollution.

Countries within Asia Pacific region for example have been taking actions in efforts of abating air pollution. This reaction however is generated partly due to socioeconomic developments. Dockery (2009, p.257) noted that most countries have solid policies regarding air pollution whereby such policies serve as the platform for monitoring and surveillance of air quality. Countries nevertheless differ in their response capacities towards air pollution reduction. Larger countries including India and China have institutionalized policies concerning air pollution and they have strengthened infrastructures related to ambient monitoring of air. Smaller nations including Maldives and Bhutan plus other nations in the Pacific region are still within policy-development process. Majority of countries in this region in the recent years have already established ambient standards for air quality while strengthening the related surveillance systems for diseases.

The Metal Industries and Work-Related Health Effects

Metal smelting and refining industry has the obligation of processing metal scrap and ores to produce pure metals. The industries manufacture metals to help in producing machinery, machine components tools and instruments required in other industries or other economic sectors (Germany, 2003, p.23). Various forms of alloys and metals apply in starting materials including the rolled stock (bars, strips, sheets, tubes and light sections) and the drawn stock (light sections, bars, wire and tubes). The primary metal processing methods includes:

- Smelting and Refining of the metal scrap and ores
- Casting the molten metal into a particular shape
- Pressing and hammering metals into the required shape (coal/hot forging)
- Cutting and welding sheet metal
- Sintering (i.e. heating and compressing the materials into a powder form)
- Shaping the metals over a lathe

Various techniques in this industry widely apply in finishing metals including the grinding and polishing activities, abrasive blasting plus the multiple surface finishing and coating methods (e.g. galvanizing, electroplating, anodizing, heat treatment, powder coating, e.t.c). Operations of this industry however relate to a number of health hazards upon workers and people within the surroundings. Dockery (2009, p.259) added that the increasingly dangerous silica dust could still be generated from the materials under grinding such as sand castings. Some resin-bonded wheels could similarly have fillers that generate dangerous dust, thus polluting the air.

On any circumstance, the dust volume produced from the grinding activities makes the need for precautionary measures essential. Workers operating within this industry should avoid prolonged work and wear the respiratory protective gear any time they are working or whenever necessary. Exhaust ventilation is also important particularly for workers operating in the polishing, belt sanding, finishing or other similar operational departments. In buffing activities especially, combustible textile dust raises a serious concern. All firms operating in this industry should always provide their workers with protective clothing, effective washing and sanitary facilities and the occasional medical supervision particularly for the metal grinders (MPMWI, n.d, p.1).

According to HMT (2011, p.1), environmental exposure or contamination to heavy metals could lead to grievous challenges across the globe. Exposure of humans to heavy metals moreover has increased tremendously within the last 50years, following the exponential rise in heavy metals application within industrial processes/products. Majority of occupations today involve exposure to heavy metals on daily basis such that more than 50professionals are under exposure solely to mercury. In the modern industrial society it is challenging to escape the exposure to the toxic metals and materials. The US blends tons of its toxic industrial wastes with liquid agricultural fertilizers for dispersion to farmlands across America. The possible grave effects on human health of such activities are therefore evident. Heavy metals could directly affect the human behavior through impairing their mental and neurological functioning thus influencing the production and utilization of neurotransmitter. Other health effects relate to cardiovascular and blood circulation ailments.

Building-material Industry and Work-Related Health Effects

In a different study, workers within the building material industry suffer several respiratory ailments due to exposures to asbestos, particularly the construction workers. Inhaling asbestos fibers adversely affects workers causing such diseases such as mesothelioma and lung cancer. The length of workers exposure to asbestos determines the risk level of developing respiratory ailments. The period between exposure to such environmental hazards and the initial symptoms of respiratory diseases could be as long as 30years. In this industry, past exposure effects are apparently evident and predictions indicate that they will continue rising. Wood dust is another environmental hazard in this industry. Exposure to this form of dust could result to nasal cancer because of inhaling wood-dust. Employees in the building material industries also suffer exposures to crystalline silica-based products including dust from such products as sand or cement (Rosenstock et al 2008, p.1134).

This hazard is rated number one cause of human-lung carcinogen. Inhaling this form of dust increases an individual's risk of lung-cancer and thus increasing a worker's vulnerability to such ailments. Solvents or other chemicals used in the building material industry are also environmental hazards. The workers suffer exposures to solvents or other dangerous substances, which places their health at risks. Frequent contacts with the liquid-based substances including resins, oils or cement-based products that have chromium 6 exacerbate the possibilities of skin ailments (Rosenstock et al 2008, p.1136). Extreme lead contacts can possibly damage an individual's central nervous system causing headaches, nausea and tiredness. Past studies have indicated an increased early retirement risks among painters and floor-layer workers due to solvent syndrome including memory loss and severe fatigue, among others.

Chemical Industry and Work-Related Health Effects

Exposure of workers to chemical hazards increases their risk of catching work-related diseases. This is particularly occurring due to poor organizational factors and chemical hazards, thus increasing the chemical risks. Most of the workers affected involve the outsourced and subcontracted staffs whose knowledge on chemical risks related to maintenance and cleaning activities are limited. This emerging form of employment is having adverse negative impacts among the subcontracted workers. Health effects in this industry involve inflammatory lung diseases, cardiovascular system ailments including stroke/heart attack and tumors (Rosenstock et al 2008, p.1138).

Chapter III

Methodology

This study employed both the quantitative and qualitative research techniques. The research used the retrospective person-time cohort study method to obtain the expected results. Primary and secondary data was applicable in finding the required data. Primary data used questionnaires as the primary data collection tool while various cases studies from articles, academic journals and books were helping in gathering the secondary data such as the US six city study which was discussed in Chapter II. The research took place in Saudi Arabia in three different industries (metal, building materials and petrochemical) these industries were chosen based on the Saudi Ministry of Health statistics since they are the most susceptible to occupational diseases among all industries in the country. The metal industry served as the dependant variable while petrochemical and building material industries were the control variables. The study followed the following design:

Research Design- Primary and secondary data applied. For the primary data, the design involved, comprising a sample of 178 workers (study participants) from the metal and the non-metal industries. Petrochemical workers were the highest motivated subjects with a total of 73 participants then building material and metal with 61 and 44 study participants respectively. The participants undergo study under different environmental-pollution exposure levels. In eliciting the information on the workers' health status, the researcher applied questionnaires as the data collection tool. The person time (PT) retrospective cohort study took place assessing the relative risk (RR) of air pollution exposure on respiratory diseases, occupational asthma, and scar tissue among the exposed workers. The study was stratified for smoking, former smoking and age. It also counts for seasonal allergies as well as level of education. Secondary data also was included

in conducting this study. The data generated from various case studies retrieved from journals, articles and books on diverse countries (both developing and developed) to help the research experts in getting viable results to make effective conclusions and recommendations.

Data Collection Tools and Methods- Each industry had a number of participants chosen under a random selection procedure from both the exposed and non-exposed worker groups. Workers from the metal industry served as the dependant variable while those from other industries acted as the control worker-groups. During the selection process, the researcher preliminary matched the workers from the two groups based on work experience, age and smoking habits. All the 178 study participants filled-in the presented questionnaires, which served as the major primary-data collection tool (Appendix A). The analysis of the data applied by calculating person time relative risk (RR) of the pollution on the health condition of the workers in the three groups, both the exposed and the non-exposed with regard to their total worked time in years. The level of exposure was determined by the department each employee works for making job class the criterion to indicate whether the employee is exposed or not. Management workers were considered the non-exposed since the workplace is far away from the source of pollution while operation and maintenance workers serve as the exposed worker group.

Chapter IV

Results

In this study, primary data were gathered from 178 study participants out of 300 surveys which were distributed into the workforce in three different industries: petrochemical, metal, and building materials. About 60 percent of the distributed surveys were completed which indicates a high motivation to the study. A positive bias was expected since the society where the data was gathered is known as a collectivistic society and for the nature of their collective culture.

Each industry has different level of exposure time in years to determine whether each subject is exposed to unclean air or not depending on the department he works for. Notably, petrochemical industry workers experience the highest level of exposure time to detrimental air pollutants. The total exposed time to unclean air in petrochemical industries is 637 person-years while the non-exposed time reaches 324 person-years. These figures are quite high compared to 521 person-years total exposed time in the building material industry and 73 person-years total non-exposed time and 224 person-years and 175 person-years total exposed time and total non-exposed time respectively. The results obtained from the questionnaires assigned to workers in petrochemical, metal, and building material industries show that none of the industries exhibit any substantial relative risk sufficient to cause the incident of occupational health diseases. For instance, in the metal industries, the relative risk factor was only 1.1, which does not signify any real threat of the occurrence of occupational diseases. In addition, the building material industry also did not produce a significant level of relative risk since the level attained from the research was only 0.62. This figure is also non-significant and can; thus not warrant concern regarding the occurrence of occupational health problems in the work environment. Lastly, the petrochemical industry also failed to indicate significant relative risk levels with regard to the incident of

occupational health problems. The petrochemical industry managed to register a relative risk of 0.52.

The research stratified for two vital aspects that might an impact on the result by being a confounder as well as looking for effect modifications. In essence, the research controlled for smoking habit for both current and former smokers, as well as stratifying for age. Cases with the total exposed and non-exposed for smokers and non-smokers are shown in Table 1a which represent the raw data for smoking strata. The finding showed that the Stratum Specific Relative Risk (RRs) for smoking were similar in building material and petrochemical as shown in Table 1b, which means effect modification was not present which indicates a non-stratum specific; therefore, Mantel-Haenszel (RR_{M-H}) was calculated for both industries. Smoking also was not a confounder since crude Relative Risk (RR_{crude}) is dissimilar to Standardized Relative Risk (RR_{STD}). On the other hand, metal industry showed that smoking was a confounding and effect modification was present which make it a uniform specific relative risk.

Table 1a

Raw data used to stratify for smoking habits

	Smoking		Non-smoking	
	(Cases) Person Time in Years		(Cases) Person Time in Years	
	Exposed	Non-exposed	Exposed	Non-exposed
Building material	(18) 172	(3) 22	(4) 59	(1) 4
Petrochemical	(6) 83	(4) 23	(12) 180	(4) 37
Metal	(3) 12	(3) 38	(6) 70	(1) 2

Table 1b
Smoking stratified data (95% confidence interval)

	Stratum Specific Relative Risk (RRs) for Smoking	Stratum Specific Relative Risk (RRs) for None Smoking	Crude Relative Risk (RR _{Crude})	Mantel-Haenszel (RR _{M-H})/Standardized Relative Risk (RR _{STD})
Building material	0.77	0.27	0.62 (0.21, 1.80)	0.64
Petrochemical	0.42	0.62	0.51 (0.22, 1.18)	0.52
Metal	1.36	0.20	1.03 (0.31, 3.41)	0.29

In term of age, the research considered age 36 as the criterion for age to control for subjects older than 36 year. All cases and total exposed and non-exposed person time in years for the two age categories are shown in Table 2a which represent the raw data for age strata. The results from age stratified data shown in Table 2b indicate that age was not a confounder neither did it show presence of effect modification for any of the three industries. Because Stratum Specific Relative Risk (RRs) for age older than 36 was similar to RRs for subjects younger than 36 indicating that uniformity of Stratum Specific Relative Risk (RRs). Since (RR_{Crude}) is similar to Mantel-Haenszel (RR_{M-H}) none of the industries showed that the age was a confounding.

Table 2a

Raw data used to stratify for smoking habits

	> 36 Year-Old (Cases) Person Time in Years		< 36 Year-Old (Cases) Person Time in Years	
	Exposed	Non-exposed	Exposed	Non-exposed
Building material	(15) 186	(1) 11	(7) 45	(3) 15
Petrochemical	(8) 199	(1) 20	(10) 64	(7) 40
Metal	(2) 35	(1) 21	(6) 43	(3) 19

Table 2b

Age stratified data (95% confidence interval)

	Stratum Specific Relative Risk (RRs) >36 year-old	Stratum Specific Relative Risk (RRs) <36 year-old	Crude Relative Risk (RR_{Crude})	Mantel-Haenszel (RR_{M-H})
Building material	0.89	0.78	0.62 (0.21, 1.80)	0.81
Petrochemical	0.80	0.89	0.51 (0.22, 1.18)	0.88
Metal	1.2	0.88	1.03 (0.31, 3.41)	0.96

These findings are indicative of the environmental situations in which workers in the industries work. This phenomenon emanates primarily from the fact that, in petrochemical industries, as well as building material industries, the quantity of particulate matter, dust and pollen is relatively lower than the quantity of these elements in the metal industry (Sunyer, 2001). Air pollutants in the metal industry include minute metal particles such as iron and lead, which can cause serious health problems such as lung scars. However, high ratios of workers in the petrochemical chemical industry experience breathing difficulties. Among the participants that took part in the research, several from the petrochemical industry argued that they had, at some point experienced breathing difficulties in their work environment. Workers in the metal industry did not exhibit breathing difficulties compared to the rest. In the building material industry, a number of research participants articulated that they had suffered breathing difficulties from contaminated air in their work environments. Breathing difficulties are symptoms of respiratory diseases which are the most common health complications associated with unclean air in work environments.

Part of the causes of breathing difficulties includes inhalation of smoke from various industrial activities such as manufacturing plants. In addition, smoke, which produces adverse results such as breathing difficulties, emanates from combusting substances within industries. Burning of different substances is part and parcel of most industrial processes, which aim at producing by products or gaining the most from resources (Duflo, Greenstone & Hanna, 2008). For instance, the petrochemical industry is likely to burn crude oil in order to release by products, which are both valuable and required for domestic and industrial use. Smoke from incinerators and furnaces may carry sediments from the combusting substances resulting in inhalation of these substances, which ultimately proves detrimental to the human body,

specifically the respiratory system, which includes the nose, trachea and the lungs, which are the most sensitive organs in the respiratory system. Gaseous pollutants from the petrochemical industry, as well as waste deposits from the building materials industry, cause breathing difficulties in workers and could result in more adverse health consequences such as lung and throat cancers. Carbon monoxide is the largest pollutant in work environments. The largest sources of carbon monoxide include burning fuels, metals and other materials, which developed and developing countries use in their industrial production processes.

In addition to breathing difficulties, workers in the metal, building material and petrochemical industries also experience wheezing and nasal congestion, which is also attributable to particulate matter in the air. The highest level of nasal congestion and wheezing incidents among workers occur in the petrochemical industry where a large ratio of workers indicates that they had experienced wheezing, and other workers experienced nasal congestion. On the other hand, at least a number of workers also suffered from wheezing and nasal congestion in the metal industry. This is further indicative of the air pollution inherent in these industries. Consistent nasal congestion and wheezing are known symptoms of serious respiratory problems such as lung scars and cancer. These diseases are frequently integrated with other respiratory problems such as chest pains coughing blood and respiratory disease.

Discussion

In essence, chemicals, as well as other related odors, can be formidable sources of indoor, as well as outdoor environmental quality problems in work environments. Odors are either organic or inorganic compounds, which can be pleasant or unpleasant. Certain odors are certified as health hazards while others are not. However, it is pertinent to realize that while most chemical pollutants originate from within the work environment, such chemicals can also be drawn into the work environment from external sources. Because of the risks posed by exposure to chemicals and other hazardous substances such as gaseous emissions, reducing exposure to chemical exposure is one of the most practical preventative actions, which can result in improved outcomes for both the work environment and workers' health. Chemical contaminants in the work environment come in all forms and from a variety of sources (Kymisis & Hadjistavrou, 2008). Volatile organic compounds, for instance, are common place chemical contaminants, which are found in work environments and are notable sources of odors. Volatile organic compounds are inherently organic thus contain carbon chemicals, which can easily dissolve into the air workers breathe. A variety of products found in the work environment has the potential to release volatile organic compounds. These products include adhesives, wall coverings, cleaning agents, combustion products such as fuels, carpeting and vinyl flooring. These chemicals prove detrimental to workers' health in the event that they remain uncontrolled. In such an event, indoor environmental quality issues arise even in instances where the building's ventilation system is designed and maintained with utmost precision.

Contaminated outdoor air may seep into the work environment causing serious health consequences to the workers. Some of the sources of contaminated outdoor air include exhaust from adjacent buildings (such as volatile organic compounds and odors), unsanitary debris

located near or around the work premises' outdoor air intake (this is particularly liable to allow the infiltration of various odors from the outdoor environment. Other sources of outdoor air contaminants include air pollutants such as ozone and oxides of nitrogen and sulfur and exhaust from diesel and petro powered vehicles on nearby roads or premises' parking lots and garages. Exhaust from vehicles consists of pollutants such as carbon monoxide and oxides of nitrogen. On the other hand, workers in petrochemical and building material industries are exposed to soil emissions, which could also adversely affect their health. These emissions include radon, which is colorless and odorless albeit harmful to humans. In addition, leakages from underground reservoirs such as fuel tanks could also pose substantial health effects to workers working on the ground, particularly in petrochemical industries (Hunter, 1994). Leakages from underground reservoirs could consist of among others solvent odors and gasoline, which have the potential to cause serious health complications to workers in the work environment. Other soil emissions with the potential to harm workers include contaminant from previously used sites such as oxides of sulfur and nitrogen, which are hazardous and could potentially cause respiratory problems.

Conversely, indoor emissions take root in various indoor systems, which also have the capacity to harm or injure workers in their work environments. For instance, bioerosols produced from water damage, as well as microbial volatile organic compounds (for instance, from fungi within work environments) could potentially cause breathing difficulties and other respiratory problems in workers (Levy, 2006). Other indoor emissions emerge from store supplies such as ammonia, chlorine, toners and solvents and from specialized use regions in the work environment such as print shops, laboratories and smoking lounges. Air pollution in the work environment also emerges from outdoor sources such as construction activities taking place around the work environment, such as volatile organic compounds from roofing chemicals; fire

damage experienced outside the work environment is also a prominent contaminant of air in the work environment. Accidental spills also play a monumental role in causing air pollution in work environments, which ultimately results in the incident of health problems such as chest pains, coughing blood or wheezing, which are some symptoms of respiratory disease.

However, it is clear from the research results that other factors beyond workers and employers' control also produce unclean air in the work environment. For instance, the depletion of the ozone layer as a consequence of global warming can ultimately injure workers' health. Foreign bodies such as particulate found in the air in work environments ultimately prove harmful to living things in the environment. Plants also suffer as a result of adverse matter found in the air. It is quite common to notice that plants lose their lively attributes in the face of an environment plagued with contaminated air. However, some of the most significant air pollutants, which can be found in work environments such as metal, petrochemical and building material industries, include vapors, hydrogen sulfide, sulfur dioxide, fluorides and vapors (Hunter, 1994). Chemical industries such as the aforementioned industries, as well as refineries, glass manufacturers paper mills and ceramics manufacturers play a significant role in polluting the air both within and without their premises.

The findings of the research conducted among 178 participants in the three industries points out that air quality in the work environment is rated less than 4 out of 10 in each one of the industries. Poor air quality particularly responsible for respiratory infections. These infections are associated with indoor air pollution, smoking and second hand tobacco smoke, as well as other outdoor air pollutants. In most developed nations, at least 20% of lower respiratory infections are attributable to environmental sources, and this figure rises to around 42% in developing nations. Workers often become concerned when they show symptoms or health

complications that result from exposure to contaminants in their work environments. Part of the reason for this concern is the fact that these symptoms often disappear, and the workers feel healthy when they are away from the work environment. Although researchers have shown time and again that certain respiratory diseases and symptoms are associated with damp air conditions in work environments, it still remains unclear what measurements of indoor contaminants prove that workers are at risk of suffering from diseases as a consequence of breathing damp air. In a majority of cases where a worker or his physician suspects that the work environment is responsible for a certain health condition, the information is often present in medical tests, as well as environmental tests. However, in most cases, results from such tests are not sufficient to provide a succinct description of which contaminants are responsible for the disease and symptoms exhibited by the worker (Kymisis & Hadjistavrou, 2008). Regardless of uncertainty regarding what element to measure, as well as how to interpret the results, research indicates that work related symptoms are distinctly associated with characteristics of the work environment, which include ventilation features, dampness and overall cleanliness.

Indoor environments are extremely complex, particularly when dealing with industrial situations. Building occupants are often exposed to contaminants, which may include artificial and natural elements. Other elements such as indoor temperatures, levels of ventilation and humidity also affect the quality of air within indoor work environments. This means that appreciating the source of work environment contaminants and finding ways to control them can ultimately help to deter or deal with work related worker symptoms and diseases. Notably, workers who exhibit persistent or worsening symptoms must always seek medical evaluations with the view of establishing proper diagnosis, as well as obtaining recommendations regarding treatment alternatives for the condition. The research findings from the questionnaires completed

by workers show that less than half of the entire worker population in the three industries encompassed in the research is aware of respiratory diseases, which emanate primarily from their contact with contaminants found in the work environment. For instance, only 55 out of 73 workers from the petrochemical industry showed knowledge of respiratory diseases while 51 out of 61 workers and 34 out of 44 workers from the building material and metal industry respectively demonstrated awareness of respiratory diseases attributed to poor air quality in work environments.

Knowledge of health consequences brought by contact with poor air quality is a valuable tool, which organizations can use to ensure that their workers remain healthy and productive throughout their periods of employment. It is, therefore, vital for industry owners and other stakeholders such as health care professionals to ensure that workers are always aware of the implications of poor air quality within the work place (Sunyer, 2001). It is the responsibility of employers and industrial entrepreneurs to provide their workers with safe working environments, which are free from air contaminants that could prove detrimental to workers' health. Employers should also offer sufficient health care coverage to their workers to ensure that the latter receive proper and timely annual physician checkups to identify and deal with health problems sufficiently early. Quite a few workers who participated in the research received the recommended annual physician checkup. For instance, in the metal industry where workers were exposed to seriously detrimental air pollutants, only 15 out of 34 workers underwent annual medical checkups. On the other hand, only three and 22 out of 73 workers underwent annual physician checkups in the building material and petrochemical industries.

Occupational health and safety risk management plays a viable role in deterring the incident of diseases and symptoms attributed to work place environments. The purpose of occupational health and safety risk management is to do away with or reduce the incident of illness and injuries associated with work environments (Sunyer, 2001).

While findings from the questionnaires assigned to workers in the primary data collection part of this research are quite viable and applicable to the present knowledge of the detriments of poor air quality in the work environment, findings from the literature review are also quite crucial. The results of the extensive literature review conducted in Chapter 3 indicate that the operations of most industries such as building materials, chemical and metal industries are ordinary pollutants in the work place (Levy, 2006). In addition to impacting the surrounding communities, the activities performed by these industries also adversely affect the health of their workers, specifically as a result of constant exposure to poor air quality in the work environment. While researchers have studied the implications of indoor and outdoor air contamination, such studies remain inadequate in the evaluation of the long term health implications of air pollution both within and without the work environment. Workers' health reactions to various psychological, as well as physical elements in indoor environments are becoming increasingly personal, complex and impeccably defined. However, universal knowledge points out the qualitative relationship existence between air pollutants, which deplete air quality, and health implications on workers.

Chapter V

Summary, Conclusion and Recommendations

In-depth knowledge regarding the effects of air pollution on humans, particularly in the workplace is quite crucial to the establishment of robust strategies aimed at dealing with the issue and ensuring that no worker experiences health difficulties or dies as a result of polluted air in the work environment. Such knowledge is also quite critical to the establishment of effective policies that ensure reductions in these adverse events, which are related to air pollution in the work environment. This form of understanding is vital to nations affected by the issue of air pollution, specifically less developed countries (LDCs), which do not have sufficient and effective regulatory frameworks to ensure timely assessment and management of air quality within workplace environments. Nonetheless, there is a need for both developed and developing countries to design and put into practice effective strategies and techniques, which focus on achieving substantive improvements in the workplace (Duflo, Greenstone & Hanna, 2008). Such monitoring competence is required in all industrial environments across the board.

While these strategies are vital in reducing and obliterating industrial pollutants in the workplace environments, they are also effective in providing frameworks for the establishment of effective working environment standards. These working environment standards typically focus on the preservation workers' health and ensuring their continued productivity within the work environment. This paper focused on investigating the correlation between the quality of air in the work environment and the incident of occupational health problems. The occupational health of all workers is vital to the realization of organizational productivity and overall industrial growth. The research specifically attempted to ascertain whether workers in the metal industries were at greater risk of suffering from air-related occupational health problems than

those working in other industries such as petrochemical and building materials industries. This examination encompassed a qualitative and quantitative collection of information using both secondary and primary information. A survey, which consisted of questionnaires, was the key primary data collection strategy employed in the research. Secondary data was largely collected from a lot of literature on the subject of air quality and occupational health.

In this study, primary data was gathered from 178 workers in the petrochemical, metal and building materials industries. The most cases (affected workers by occupational health problems) were those that worked in the metal industries. Although workers in the petrochemical and building materials industries also suffered various forms of occupational health issues, the level of such suffering was relatively low. Even though none of the industry showed a significant Relative Risk (RR), this result exemplified the notion that the metal industries exhibits greater occupational health risks than the petrochemical and building materials industries. Workers, in industries continue to be subjected extremely prolonged durations of unsafe air quality, which ultimately puts them at risk of acquiring serious respiratory diseases, as well as symptoms such as, among others, nasal congestion, chest pains, coughing blood, wheezing and lung scars. The results realized from the research effectively point out that industrial workers spend a massive portion of their time being exposed to unclean and unsafe air. Comparisons between the total exposed time and total unexposed time indicate succinctly that industrial workers, particularly in metal and petrochemical industries are highly exposed to unsafe air quality. These results are indicative of the dire conditions in which industrial workers function. This is particularly the case in industries with a high incident of air pollution compared to conventional workplace environments such as offices.

The contamination of the air in workplace environments deters the effective progress of work and further reduces the capacity of workers to achieve their optimal productivity in an effective and efficient manner. Health consequences that emanate from occupational air unsafely and lack of overall cleanliness produces immense adverse effects in the work environment. In addition to occupational diseases, unsafe and unclean air in the workplace environment also produces other detrimental effects such as workplace accidents. For instance, smoke produced by varied industrial processes can reduce workers' visibility within the industry. This ultimately results in occupational accidents or even death. Air quality in the work place is, therefore, of prominent significance, not only with regard to occupational diseases but accidents, as well. Upper respiratory tract diseases are the most prevalent in workplace environments and emanate from inhalation of hazardous air, which consists of contaminants such as, among others fumes, smoke and volatile organic compounds. Participants in the research helped to affirm the fact that poor air quality in the workplace produces detrimental health effects on workers, both indoor and outdoor.

However, the most affected workers by unsafe air quality in the workplace are those found in indoor environments. These environments are often enclosed and may lack effective or sufficient ventilation to allow for the injection of fresh and clean air in the environment and expulsion of unclean and unsafe air. Ventilation is a critical component of ensuring air quality within the workplace environment.

Conclusion

Air pollution refers to a situation in which the quality of air is impeded by the presence of a large quantity of contaminants. In work environments, air pollution occurs through a variety of contaminants, which include, among others, smoke and other gaseous emissions, chemicals and dust. The occurrence of these contaminants in air found in workplace environments results, in the development of occupational health problems, which plague employees and diminish their levels of productivity and overall health. A majority of contaminants in the workplace environment include dust and smoke (Hunter, 1994). Dust refers to airborne particulate matter that is finely divided solid or liquid material with less than 100 micrometers in diameter. Most gaseous emissions take place in industrial production plants where processes such as thrashing, minting, shredding and other similar processes take place during the manufacturing process in industries. Within workplace environments, especially in industries, materials in the air, which contaminate such air, emerge from several sources. As noted, industrial processes such as manufacturing encompass the greatest source of air contamination. In addition, demolition sites, material handling and transfer, storage piles, construction sites and open areas also play substantial roles in contaminating air in indoor workplace environments.

The incident of air pollution in workplace environments continues to cause increased incidents of occupational health and safety issues. As a consequence, the recent years have witnessed increased awareness regarding the hazards of occupational safety and health issues inherent in indoor work environments. This awareness has, in turn, resulted in increased improvement, in terms of working conditions, which have minimized workers' exposure to the array of toxic elements found in these environments. However, occupational diseases, which emerge from substantial hazards inherent in workplace environments, continue to generate

substantive losses in terms of workers' health and productivity, as well as organizational profitability (Kymisis & Hadjistavrou, 2008). Organizations continue to experience monumental challenges, especially as a consequence of increased developments in energy, biotechnology, chemicals, biotechnology and industrial activities. There is currently an a growing tendency to develop biological and ambient limits while at the same time designing strategies for their execution, thereby deterring the emergence of health damages from exposure to toxic substances within the workplace.

Information provision is an inherent part of monitoring practices, which assist in the implementation of standards, ensuring their validation and compliance. This will eventually result in the establishment of extremely viable and applicable strategies in the future. Methods of analysis can be used to study workplace environment to ensure effective monitoring with regard to refining and metal working industries thereby providing sufficient information regarding the assessment of plausible adverse health implications in workers. Toxics such as heavy metals, as well as trace elements that produce adverse effects are exemplified through the airborne particulate they produce. The WHO (2005) posited that, in indoor workplace environments, toxic substances, specifically metals and their ensuring compounds, are quite commonplace. Occupational health focuses primarily on work-related effects, which impact workers' health while at the workplace. Occupational health is a substantial component of employer responsibility to offer care and protection to their employees while the latter are at their work stations. Government policies establish principles primarily aimed at ensuring that workers are protected from injury, disease and sicknesses, which arise from their employment, particularly with regard to indoor environments.

Air pollution signifies the presence of a massive quantity of contaminants such as smoke and dust in the body of air contained in the work place and which workers inhale. Dust is essentially particulate matter, which is airborne and finely divided liquid and solid material having a diameter, which is smaller than 100 micrometers. The research showed that smoke and dust are two of the most prevalent constituents of particulate matter. Gaseous emissions, chemical from production plants, dust, and pollen from external and internal plant life can be suspended as particles in the air. Ozone, which is a gas, is a significant part of air pollution in the work place. Whenever ozone forms air pollution, the ultimate product, is referred to as smog. In the workplace, particularly in industries, these materials emerge from a number of sources, which include industrial processes, unpaved and paved pathways within industries, demolition, as well as construction sites, storage piles, demolition sites, open areas and handling and transfer of material (Williams & Sandler, 2001).

A number of air pollutants are poisonous and could prove detrimental to human health if humans come into contact with such pollutants. This is primarily the reasons why developed and developing countries need to establish robust strategies and policies to deal with the problem of air pollution within the workplace. Inhaling such poisonous pollutants increases the chances of acquiring health problems (Hunter, 1994). As a matter of fact, the primary research conducted indicates that when workers in petrochemical, building material and metal industries inhale dust particles, they suffer from breathing problems, damage to lung tissues and aggravates existing health complications, particularly those associated with smoking.

In addition to causing, the incident of health problems, dust generated from certain activities within industries can also reduce visibility, causing accidents, injuries or even fatalities. Therefore, policy makers such as the government and labor organizations should establish and

implement stringent regulations aimed at preventing, reducing or mitigating dust emissions, as well as other air pollutants that could detrimentally affect human health (Duflo, Greenstone & Hanna, 2008).

A massive number of workers die every year as a consequence of work-related diseases and accidents while even larger numbers experience non-fatal work related injuries every year. The agony and suffering set off by such accidents and illnesses to workers, as well as their families is essentially incalculable. With regard to economic terms, researchers estimate that at least 4% of the entire world's annual GDP is lost as a result of occupational accidents and diseases (Plog, Quinlan & Villarreal, 2012). Employers continue to face costly early retirements, absenteeism, high insurance premiums and loss of skilled and professional staff as a consequence of work-related diseases and accidents. Environmental engineering is one of the most prominent strategies used in the development of strategies to deal with environmental problems in the workplace. These solutions include, among others actions such as controlling pollution levels, recycling and proper waste disposal (Levy, 2006). Environmental experts are quite valuable in the workplace since they hold sufficient expertise with regard to how to conduct effective hazardous waste management. These professionals engage in research aimed at analyzing the significance of hazards, providing assessments regarding proper treatment of identified hazards and developing viable controls to prevent workplace mishaps.

The field of environmental engineering encompasses the use of chemical and biological systems to incorporate local, as well as international environmental issues, which affect organizations and their indoor environments. Some of the most prominent studies conducted in the field of environmental engineering and which enable stakeholders to deter the incident of accidents, diseases and fatalities, include ways to diminish the implications of global warming,

ozone depletion, emissions and acid rain (WHO, 2005). On the topic of outdoor and indoor work environments, air pollution contributes significantly to detrimental effects experienced by living things. Atmospheric pollution is the term environmental professionals use to define air pollution. According to the WHO, air pollution refers to the foreign materials present in the air, which are potentially detrimental to living things whenever they come into contact with the limit of concentrations levels for such materials.

Foreign bodies present in the air found in indoor workplace environments serve as pollutants, which include hydrogen sulfide, fluorides, vapors and sulfur dioxide. A majority of air pollutants found in the workplace include lead, which causes retardation in intellectual development, as well as serious effects on workers' behavioral patterns. When lead levels in the indoor environment reach their maximum threshold, lead can cause miscarriages amongst female workers, impaired renal functioning and increases blood pressure. Iron dust, which is commonplace in metal industries, can cause serious cases of siderosis (Mateen & Brook, 2011). This refers to a form of pneumoconiosis disease, which affects the lungs and other respiratory organs. Ozone, on the other hand, produces photochemical smog and is associated with impaired lung functioning, asthmatic attacks, as well as other respiratory diseases. Although ozone does not necessarily omit directly, it forms within the atmosphere through photochemical reactions with nitrogen oxides, as well as other reactive hydrocarbons. Since ozone is typically insoluble in water, it has a high propensity to cause lower respiratory diseases since gases with low solubility levels typically pass via the alveolar lining into the blood stream to target the relevant organ, which in this case are the lungs.

The health implications of particulate matter in the air within workplace environments include chronic bronchitis, asthma, heart and lung diseases, as well as other respiratory problems or death. The implications of particulate matter increase concurrently with the decreasing size of the particles of particulate matter (Williams & Sandler, 2001). On the other hand, the oxides of sulfur, which also feature prominently in air contaminants, in the workplace environment, are attributed with causing changes in the normal functioning of the lungs, particularly amongst people who suffer from asthma. In addition, the oxides of sulfur are also responsible for exacerbating the symptoms inherent in respiratory problems amongst sensitive persons. In the outdoor environment, the oxides of sulfur are also known to cause acid rain, as well as small particle formations through atmospheric reactions, referred to as secondary particles thereby enhancing particulate matter load simultaneously.

Conversely, workers, especially in industries also fall victim to the effects of the oxides of nitrogen. These oxides affect the normal functioning of the lungs, particularly in people suffering from asthma. Nitrogen oxides also contribute to the formation of acid rain, as well as the formation of secondary particulate. The oxides of nitrogen are also precursors of the formation of ozone at the ground level (Williams & Sandler, 2001). Lastly, another significant cause of work-related illnesses and accidents in the indoor work environment is carbon monoxide, which deters the capacity of blood to transport oxygen to body tissues and organs. People who suffer from chronic heart diseases could potentially experience chest pains, especially in the event of high carbon dioxide levels in the work environment. When carbon dioxide in the air in the work environment reaches extremely high levels, it results in the impairment of vision, as well as manual dexterity.

Recommendations

As part of the strategies aimed at enhancing workplace safety and guaranteeing workers of health working environments, the International Labor Organization's (ILO) established a variety of standards and principles to guard the achievement of safety in workplace environments. Therefore, in order to attain optimal indoor workplace environment safety and ascertain the health of workers, particularly those working in industries, it is critical for organizations and industries to implement ILO's standards in their day to day operations. ILO's standards on occupational safety and health offer a number of vital tools for institutions, governments, workers and employers to design and implement such practices and provide maximum safety levels at the workplace (Mateen & Brook, 2011). In the year 2003, ILO established and adopted the global strategy to enhance occupational health and safety, which encompassed the introduction of a preventive health and safety culture, the advancement and growth of relevant instruments and tools, as well as technical assistance. Some of the most prominent fundamental principles of occupational health and safety established by ILO include the occupational health and safety convention of 1981 and its ensuring 2002 protocol, which provides for the integration of a coherent national and international occupational health and safety policy, as well as initiatives to be instituted by governments and within organizations to enhance occupational health and safety. This principle also aims at the improvement of workplace conditions, which have a direct bearing on workers' health and safety.

This principle also includes the establishment of coherent strategies aimed at enhancing the quality of air in indoor workplace environments. The ILO proposes the development of the policy by taking into account national practices and conditions regarding workplace safety. This protocol calls for companies and governments to design and implement and constantly assess

procedures and requirements aimed at recording and announcing occupational diseases and accidents as a consequence of work-related hazards (Mateen & Brook, 2011). The protocol also aims at the publication of related yearly statistics regarding workplace accidents and injuries to ensure that affected institutions and industries establish supplementary strategies and policies to fortify the existing health and safety policies. In addition, it is critical for industries and organizations to implement proposals of ILO's occupational health services convention of the year 1985, which provide for the creation and implementation of enterprise level occupational health services that are entrusted with preventative functions. These occupational health services are additionally responsible for providing advice to the employer, workers, as well as their representatives within the enterprise, particularly with regard to ensuring and maintaining a healthy and safe working environment, both indoor and outdoor (OSHA, 2012).

Part of this paper's recommendations on ways of improving workplace safety to promote worker health includes the implementation of the 2006 promotional framework established to ensure occupational safety and health (ILO, 2012). The purpose of this convention is to promote a preventative culture in which organizations and industries progressively aim at the achievement of a wholesome and nontoxic working environment. The principle also requires that countries and their individual governments work cooperatively with representative organizations of workers and employers, to develop national policies, national systems and national programs aimed at guaranteeing occupational health and safety within workplaces. These national policies need to be developed in accordance with the principle number 155 of the 1981 occupational safety and health convention (ILO, 2012). On the other hand, national systems, as well as programs, should be designed and implemented by taking into consideration the principles established by pertinent ILO instruments. National systems should aim at the provision of

pertinent infrastructure necessary for the implementation of national programs and policies regarding occupational health and safety, for instance, regulations and laws, bodies and authorities. The systems should also aim at the implementation of compliance mechanisms such as the arrangement at various undertaking levels and systems of inspections. Conversely, national programs should also encompass, among others, time-bound measures aimed at promoting occupational health and safety, as well as enabling the measurement of progress at various intervals.

Conversely, the ILO also provides principles to ensure employee and worker protection against specific work-related risks. These principles also encompass those that guard against work-related illnesses and accidents caused by the working environment, for instance, in terms of air pollution, vibration and noise. ILO's 1977 ratifications regarding proper working environments require that, as far as possible, employers and enterprise owners should certify that the workplace is preserved free from hazards caused by air pollution, vibration or noise. Therefore, in order to attain this objective, organizations must implement applicable technical measures, as well as processes, and in cases where this is impossible, organizations must institute supplementary measures concerning the organization of work (ILO, 2012). Air pollution in the work environment has the propensity to cause lung cancer. Therefore, there is an enormous need for employers to conform to the ILO standards established in the year 1974 concerning occupational cancer convention. In essence, organizations should implement the occupational cancer principles, which primarily aspire for the establishment of mechanisms for the development of policies to deter the risks of occupational cancer, which occur as a consequence of exposure to toxins over prolonged periods (OSHA, 2012).

These toxins include, among others, various forms chemical, as well as physical agents, which are present in workplace environments. For this purpose, countries are required to ascertain continuously various carcinogenic elements, agents and substances to which prolonged occupational exposure shall be deterred or regulated, to institute every effort to find appropriate alternatives for these substances. The occupational cancer principle also aims at replacing carcinogenic agents with non-carcinogenic ones and prescribes supervisory and protective measures and prescribes appropriate medical examinations for all workers exposed to carcinogenic agents, substances and elements. Part 170 of the 1990 chemicals convention also provides for the espousal, as well as implementation of coherent policies regarding safety with regard to the use of chemicals within the work environment (ILO, 2012). This includes the handling, production, storage and transportation of chemicals, as well as the treatment and disposal of waste chemical products. In addition, the principle also requires organizations to establish appropriate strategies and policies for the release of chemicals produced from work activities, as well as the repair, cleaning and maintenance of chemical containers and equipment to ensure that workers and employees do not come into contact with potentially unsafe chemicals. Furthermore, the principle allocates specific responsibilities to exporting countries and organizations and suppliers.

In addition to dealing with gaseous and chemical substances, which produce work-related diseases and accidents, employers should also focus their attention on eliminating the incident of dampness, which also causes detrimental effects on workers' health. Dampness primarily originates from water incursion from external sources such as rainwater or internal sources such as leaking pipes. In essence, dampness becomes a serious problem when materials in the indoor work environment such as ceiling tiles, walls and rugs absorb water for prolonged periods. The

incident of excessive moisture in the air, which is also referred to as high relative humidity, which is improperly controlled with inadequate air conditioning, can ultimately result in excessive dampness (Hunter, 1994). Dampness, in the work environment, also causes serious occupational health problems; hence the need to find ways of effectively dealing with the issue. Part of the remediation used to deal with dampness is to identify the source of moisture or water and implement appropriate measures to perform repairs and eradicate the problem completely. In addition, wet or damp furnishings and materials should always be thoroughly dried within the span of 24 to 48 hours in order to deter the growth of mold, some of which are known to be poisonous.

However, preclusion is always better than treatment; hence the need to design and implement effective strategies and policies aimed at curtailing the incident of dampness in indoor work environments. Perhaps the most recommendable preventative strategy is to ensure that dampness and mold do not occur in the work environment is to ensure periodic premises repairs and maintenance to deter leakages, which result in dampness and mold formation. It is pertinent that organizations institute their own sets of policies aimed at ensuring that the indoor workplace environment remains safe and healthy (ILO, 2012). Workers also have a crucial role to play in the process of designing and implementing strategies and policies geared towards reducing the incident of work-related health problems. For instance, workers should work cooperatively with their supervisors and employers to highlight work-related health hazards and institute proper guidelines to deal with existing hazardous materials, which could prove detrimental to workers' health. There are various air pollution control technologies, which companies can implement to deter the occurrence of workplace accidents and occupational health issues.

These strategies are available to enhance the reduction of air pollution and help organizations to develop the most appropriate infrastructure to deal with issues regarding occupational health issues. Land use planning is a viable approach, which organizations can use to ensure that occupational diseases; accidents and death do not occur. Land use planning, in this sense, could involve the appropriate placement of production plants, as well as other industrial processes away from offices to deter contaminants from infiltrating air in the offices (Duflo, Greenstone & Hanna, 2008). Conversely, employers should provide their employees with the most appropriate safety implements, coverings and clothing to deter direct contact with pollutants with the capacity to cause occupational diseases, accidents or death.

Ventilation: Ventilation has a significant impact on the quality of air in workplace environments. Ventilation refers to the process of supplying clean and safe air to an enclosed space so as to remove, replace and refresh the existing atmosphere (Plog, Quinlan & Villarreal, 2012). The essence of ventilation is the removal of contaminants such as vapors, dust, smoke and fumes and the provision of a safe and healthy working environment. Ventilation is accomplishable through natural means, for instance by opening windows in work environments or mechanical methods such as blowers and fans. However, by itself, the term ventilation does not necessarily show whether the exhausted air is cleaned or filtered prior to being discharged. Additionally, it does not point out whether incoming air is treated, cooled or heated before being pumped into the indoor environment. Ideally, ventilation aims at the provision of humidity, temperature and air quality in enclosed spaces.

Ventilation continues to be a critical concern in a majority of occupational activities, which produce fumes, vapors, mist and dust. These activities include, among others, soldering,

and grinding, welding, painting, brazing and using flammable and volatile chemicals.

Organizations can lessen their need for ventilation by minimizing the quantity of airborne contaminants generated in the course of occupational activities. For instance, in order to reduce the need for ventilation, workers should keep containers of volatile organic compounds tightly sealed whenever they are not in use or alternatively utilize materials that do not consist of VOCs (Plog, Quinlan & Villarreal, 2012). In addition, organizations can also modify their processes to deter the formation of mist and vapors and separate work areas to reduce the spread of dust. However, these alternative ways of lowering the need for ventilation are often unattainable thereby enhancing the need for ventilation. Ventilation systems essentially control hazardous material from harming workers in work environments. These systems consist of two fundamental systems, which include general ventilation and local exhaust ventilation. These broad classes of ventilation systems allow businesses to maintain clean and safe air quality within work environments.

General ventilation, which is also referred to as fresh air ventilation or dilution, refers to a system that simply dilutes concentrations of hazardous materials found in the air by bringing in fresh and clean air. Some of the most notable examples of general ventilation systems are windows and cooling fans. General ventilation is particularly applicable in the work environment whether the quantity of harmful material present in the air is constant and minute. In addition, general ventilation is feasible in the event that the movement of air is adequate to keep the concentration of hazardous materials at minimal and acceptable levels and when hazardous materials encompass low flammability and toxicity. Lastly, businesses can use general ventilation in the event that the material would not otherwise detrimentally impact the environment or workers, for instance, harmful dusts, foul odors and corrosion. As a method of

ensuring worker protection against airborne contaminants in the work environment, it is pertinent to realize that general ventilation does not entirely eliminate contaminants and is ineffective against highly toxic chemicals that infiltrate air in the workplace (Plog, Quinlan & Villarreal, 2012). Notably, certain general ventilation systems such as fans often blow the air contaminants around the work area rather than effectively controlling the contaminants. This is detrimental with regard to the health of workers since contaminants remain within the work environment and are blown around the environment, impacting more and more workers since air movement remains uncontrolled. In essence, the volumetric rate at which general ventilation works depends solely on how fast the contaminants infiltrate the air, as well as the rate at which fresh air mixes with air in the work environment.

On the other hand, local exhaust ventilation refers to a form of engineering control, which encloses work environments, equipment, processes and materials ensuring that indoor environments receive sufficient amounts of clean air flow at necessary rates or intervals (Plog, Quinlan & Villarreal, 2012). A viable example of a local exhaust ventilation system is a fume hood. In order for local exhaust ventilation to work effectively and efficiently, there should be no obstructions to the air intake or blockages in the fresh make-up air sources. In addition, workers must perform occupational activities within the air intake region in order to realize optimal results from local exhaust ventilation systems. Local exhaust ventilation systems work effectively when workers do not perform occupational activities between the source of contaminants and the air intake source. Otherwise, workers will be extremely exposed to high contaminant levels, which, in turn, prove detrimental to workers' health. Clearly, local exhaust ventilation is the preferential method since it moves small air quantities more efficiently than general ventilation. This results in massive savings in terms of cooling, as well as heating costs.

In work environments, ventilation effectively controls workers' exposure to airborne contaminants, which are detrimental to their health; thereby ensuring the provision of safe and healthy working environments. Industrial ventilation systems are developed in ways that move a certain quantity of air at a certain velocity, which results in the elimination of undesirable air contaminants. Although all ventilation systems adhere to the same fundamental principles, each system is developed specifically to suit a certain occupational activity, as well as rate of contaminant present in the work environment. In order to ensure that workplace ventilation systems function effectively, organizations should routinely inspect and test their ventilation systems. Workers should also be provided with training regarding emergency and routine operating procedures for ventilation systems and incorporate these practices with organizational ventilation control programs. These programs adhere to OSHA, as well as NIOSH provisions on effective workplace ventilation. These include having written procedures and standards for ventilation operation and ensuring the conduct of routine inspections on a daily or weekly basis depending on the level of toxicity of exhaust substances.

Occupational Safety and Health Administration (OSHA) standards also require the establishment of routine cleanout schedules for dropout boxes, settling chambers and dust collectors to deter reentry of contaminants in the clean and healthy air in work environments. The standards also require employers to post operating and emergency ventilation operation procedures and ensure all workers are conversant with their use. Other requirements include operator training, routine maintenance, use of personal protective gear whenever necessary and conducting regular medical examinations on workers exposed to unclean and unsafe air in the work environment. There is also a need to consult local fire marshals regarding vents, particularly in fire hazard regions of the workplace, for instance, combustion chambers. OSHA

requires these areas to be designed to close and open automatically in case of a fire so as to deter smoke from infiltrating air in the work environment and causing occupational health problems.

OSHA allows for the initiation of workplace investigations regarding ventilation systems to be done by worker complaints regarding plausible exposure to air contaminants or other air quality issues.

References

- Dockery, W. (2009). *Health effects of particulate air pollution. Annals of Epidemiology. 19(4):257-263*. Retrieved from:
<http://www.nejm.org/doi/full/10.1056/NEJM200401083500225>
- Environmental Trends: Health in Asia and the Pacific (ETHAP, 2010). *World Health Organization Journal. 1(1):76-125*. Retrieved from:
http://www.wpro.who.int/NR/rdonlyres/5FE0751B-0123-4BFC-AC2E-FD51D6F36764/0/09_Chapter4Environmentaltrends.pdf
- Gadgil, A., Rafiei, M., Ghole, V., Jaafarzadeh, N., Mirkazemi, R. & Gore, S. (2009). Assessment of Air Pollution and Its Effects on the Health Status of the Workers in Beam Rolling Mills Factory (Iran National Steel Industrial Group) from Ahvaz-Iran. *Indian J Occup Environ Med. 13(1):20-22*.
- Germany, B. (2003). Health Aspects of Air Pollution with Particulate Matter, Ozone and Nitrogen Dioxide. *WHO Working Group. 13(15):1-98*
- Hays, J. (2008). *Air Pollution in China*. Retrieved on January 20, 2012 retrieved from:
<http://factsanddetails.com/china.php?itemid=392&catid=10&subcatid=66>
- Hazard Prevention and Control in the Work Environment: Airborne Dust (HPCWE, n.d). *Occupational Health Journal. 99(14):1-96*
- Health Statistical Year Book*. (HSYB, 2009). Retrieved on March 2, 2012 retrieved from:
<http://www.moh.gov.sa/Ministry/Statistics/Book/Pages/default.aspx>
- Heavy Metal Toxicity (HMT, 2011). *Tuberoze.com*. Retrieved on April 5, 2012 retrieved from:
http://tuberoze.com/Heavy_Metal_Toxicity.html

- International Atomic Energy Agency (IAEA, 2008). Assessment of Levels and Health Effects of Airborne Particulate Matter in Mining, Metal Refining and Metal Working Industries using Nuclear and Related Analytical Techniques. *IAEA Journal*. 92(6):1-234
- Metal Processing and Metal working Industry* (MPMWI, n.d). Retrieved on February 15, 2012
retrieved from: <http://ilocis.org/documents/chpt82e.htm>
- Reijula, K. (2008). Healthy Air, Better Work Now and Forever. *SJWEH Suppl Journal*. 1(4):83-86
- Rosenstock, L., Cullen, M. & Fingerhut, M. (2008). Occupational Health. *Organizational Journal*. 6(1):1127-1138
- Share Air Pollution & Respiratory Disease*. (SAPRD, 2012). Retrieved on March 10, 2012
retrieved from <http://www.niehs.nih.gov/health/impacts/respiratory/>
- Duflo, E., Greenstone, M., & Hanna, R. (2008) Indoor air pollution, health and economic well-being. *S.A.P.I.E.N.S I* (1).
- Hunter, D. (1994). *Diseases of occupations* (8th ed.). Connecticut: Hodder Arnold.
- International Labor Organization (ILO). (2012). *Occupational safety and health*. Retrieved from <http://www.ilo.org/global/standards/subjects-covered-by-international-labour-standards/occupational-safety-and-health/lang--en/index.htm>
- Kymisis, M. & Hadjistavrou, K. (2008). Short-term effects of air pollution levels on pulmonary function of young adults. *The Internet Journal of Pulmonary Medicine*, 9 (2).
- Levy, B. S. (2006). *Occupational and environmental health: Recognizing and preventing disease and injury: LWW medical book collection* (5th ed.). Ohio: Lippincott Williams & Wilkins.

- Mateen, F. J., & Brook, R. D. (2011). Air pollution as an emerging global risk factor for stroke. *JAMA* 23;305(12), 1240-1.
- OSHA. (2012). *Occupational safety and health standards*. Retrieved from http://www.osha.gov/pls/oshaweb/owastand.display_standard_group?p_toc_level=1&p_part_number=1910
- Plog, B. A., Quinlan, P. J., & Villarreal, J. (2012). *Fundamentals of industrial hygiene* (6th ed.). Ohio: National Safety Council.
- Sunyer, J. (2001). Urban air pollution and Chronic Obstructive Pulmonary disease: A review. *European Respiratory Journal* 17 (5), 1024–1033.
- Williams, M. D, & Sandler, A. B. (2001). The epidemiology of lung cancer. *Cancer Treatment and Research*, 105, 31—52.
- WHO (2005). *Ecosystems and human health - health synthesis*. Geneva: World Health Organization.

Appendix A: Survey Questionnaire

Cover Letter

I am performing a research to examine the relationship of air quality in the work environment with Occupational Health diseases. It is designed to establish the impacts of environmental pollutions on the health of workers in three different industries. The questionnaire contains two sections: **Section I** contains personal information and **section II** contains the general information concerning the workers, and their health conditions, in relation to environmental pollution.

Finally, I would like to thank you in advance for your time and your participation in this study. I also would like to assure you that all surveys and all answers are anonymous. Do not hesitate to contact me if you have any questions regarding to the survey or if you are interested in the results which will be analyzed by December 1, 2012. Please answer all the questions as desired and be brief when explaining your answer.

Conducted by:
HussienAlumar
e-mail:halumar@hotmail.com
Cell: 0553805659

الملحق أ: الإستبئانة**خطاب تقديمي:**

أقوم بالعمل على بحث علمي لاختبار العلاقة بين جودة الهواء في محيط بيئة العمل والأمراض المهنية. هذا البحث مخصص لإيجاد عوامل التلوث البيئي والتي قد تؤدي إلى الإصابة ببعض الأمراض المهنية حيث ستم الدراسة في ثلاث صناعات مختلفة. الإستبئانة مكونة من قسمين رئيسيين: **القسم الأول** يحتوي على بعض المعلومات الشخصية بينما **الجزء الثاني** يحتوي على معلومات عامة تركز على الموظفين وحالتهم الصحية في ظروف التلوث البيئي.

في الختام أود أن أشكر كل من سيقدم المساعدة على وقته الثمين وعلى التعاون في هذه الدراسة. كما أود التنويه بأن جميع المعلومات والإجابات في هذه الإستبئانة ستكون مجهولة الاسم حيث لا يمكن الإطلاع علي أي معلومات شخصية. في حالة وجود أي استفسار بخصوص الإستبئانة لا تتردد بالاتصال على الجوال أو البريد الإلكتروني الموضح أدناه. في حال الرغبة في الإطلاع على نتيجة البحث يمكنك التواصل معي أيضا حيث ستم تدقيق البيانات في الأول من ديسمبر 2012.

الرجاء الإجابة على جميع الأسئلة بكل اختصار.

مقدم البحث:

حسين عوض آل عمر

البريد الإلكتروني: halumar@hotmail.com

رقم الجوال: 0553805659

Survey Instrument

SECTION I: PERSONAL INFORMATION

Please circle your response

1. How old are you?

2. What is your level of education attained?

Primary secondary Some College Post-graduate

Years of Experience:

3. What is your employment type?

Permanent Contract Seasonal

4. Which Industry do you work for?

Metal Petrochemical Building Material "Cement"

If other, please explain:

5. What department of the industrial do you work at?

Management Operation Maintenance

If other, please Explain:

آلية الاستبانة:

القسم الأول: المعلومات الشخصية

الرجاء وضع دائرة حول إجابتك

1 . كم عمرك؟

2. ماهو مؤهلك العلمي؟

دراسات عليا	جامعي	ثانوي	متوسط	ابتدائي
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3. ماهي نوع الوظيفة؟

رسمي	متعاقدا	صيفي
------	---------	------

4. في أي الصناعات تعمل؟

الحديد	البتر وكيمويات	مواد البناء (الأسمنت)
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غير ذلك حدد:

5. في أي قسم تعمل؟

الإدارة	التشغيل	الصيانة
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غير ذلك حدد:

SECTION II: GENERAL INFORMATION

6. Are you a smoker?

Yes No

If yes; approximately, how long in years has it been?

If no; have you smoked before?

7. Do you know what respiratory diseases are?

Yes No* (Chronic diseases of the airways and other structures of the lung
some of the most common are: chronic obstructive pulmonary disease and respiratory
allergies)

8. Do you have difficulty to breath?

Yes No

9. Do you produce a wheezing sound when breathing?

Yes No

10. Do you experience nasal congestion and nasal discharge?

Yes No

11. Do you experience pain, or find it difficult to swallow?

Yes No

12. Do your eyes get itchy and watery?

Yes No

13. Do you have occupational asthma (asthma that is caused by the exposure to some
substance or air pollution in the work place?)

Yes No

القسم الثاني: معلومات عامة

6. هل أنت مدخن؟

نعم لا

إذا كانت إجابتك نعم، فما هو عدد سنوات التدخين؟

إذا كانت الإجابة بلا، فهل كنت مدخناً في السابق؟

7. هل تعرف أمراض الجهاز التنفسي؟

نعم لا* (هي عبارة عن أمراض مزمنة تصيب مجرى الهواء في الجهاز التنفسي بما في ذلك الرئتين ومن الأمراض الأكثر شيوعاً الانسداد الرئوي المزمن والحساسية في الرئتين.)

8. هل تعاني من صعوبة في التنفس؟

نعم لا

9. هل تصدر أصوات صفير أو حشرجة أثناء التنفس؟

نعم لا

10. هل لديك احتقان أو رشح في الأنف؟

نعم لا

11. هل تشعر بالآم أو صعوبة أثناء البلع؟

نعم لا

12. هل لديك حكة أو دموع في العينين؟

نعم لا

13. هل تعاني من الإصابة بأمراض الربو المهنية (الإصابة بالربو نتيجة التعرض لبعض المواد أو التلوث في مكان العمل)

نعم لا

14. Do you experience chest pains and congestion?

Yes No

If yes, please explain if it is severe.

15. Do you sometimes cough blood?

Yes No

16. Do you have seasonal allergy?

Yes No

If Yes, what season?

17. Do you have annual physician?

Yes No

18. If yes, have you diagnosed with lung scar tissue which makes parts of the lungs appear white in the x-ray?

Yes No

19. When was your last x-ray?

20. Have you been diagnosed with any respiratory diseases?

Yes No

21. By marking "X" anywhere between "Worst" and "Best", how do you rate the air quality in your work environment?

Worst

Best



14. هل تعاني آلام و احتقان في الصدر؟

نعم لا

إذا كانت إجابتك بنعم، وضح إذا كانت حادة.

15. هل تقذف دم أثناء السعال أحياناً؟

نعم لا

16 هل لديك حساسية فصلية؟

نعم لا

إذا كانت إجابتك بنعم، ففي إي فصول السنة؟

17. هل لديك طيبب دوري؟

نعم لا

18. هل تم تشخيصك بالنسج الندبي في الرئتين والذي يظهر بياض في الرئتين عند أخذ الأشعة السينية؟

نعم لا

19. متى قمت بأخذ آخر أشعة سينية؟

20. هل تم تشخيصك بأمراض الجهاز التنفسي؟

نعم لا

21. بوضع علامة "إكس" بين "الأفضل" و "الأسوأ" كيف تقيم جودة الهواء في محيط العمل؟

الأسوأ

الأفضل

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