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Assessing the Risk of Working with Chemicals in an Automotive Unit

Amir Hasssan Akbarnejad Baei[1], Moslem Heydarzadeh Kouchaksaraei[2], Siawash Safdarpour[2], Mohammad Taghipour[3,*]

Abstract

Today's human life is mixed with chemicals that can affect human health independently or independently. Also, many occupational diseases are caused by chemicals. Prevention of occupational diseases caused by exposure to chemicals saves people and improves the quality of life of other workers. The purpose of this study is to know the risks caused by chemicals and to evaluate the risk of hazards and the proposal of appropriate preventive measures in an industrial unit that manufactures cars. In this research using the method Topsis, the risk coefficient of substances was found in general and after determining the exposure coefficient of employees, the risk coefficient of exposure to chemical substances in three units were evaluated. The results show that workers in all parts of this factory are exposed to dangerous substances but in the room making workshop and paint salon, people are exposed to more chemicals. Therefore, measures should be taken in these two halls. Preventive measures have been followed with more seriousness and a suitable alternative for the hazardous chemicals of these salons has been proposed.

Keywords: Risk assessment, chemicals, exposure factor, carcinogenic, toxicity

INTRODUCTION

Currently, all over the world, one of the most important challenges is safety, protection, and prevention programs in the workplace because almost half of the accidents that occur in the industry is due to working with different hazardous factors that threaten human life and health. One of these factors is chemicals that are used in many industries today and workers are inevitably forced to accept work in such dangerous environments. It is an undeniable fact that chemicals are the key to healthy life and prosperity today. Chemicals are an important part of processes They form a different industry to produce products that are very important in global living standards, but control the release of these materials chemicals in the work environment, as well as controlling the exposure of workers and limiting their release in the environment, are among the duties of governments and employers. They should try to deal with them. What makes the work difficult is the possibility of danger associated with exposure to these chemicals. As for example, pesticides that produce better crops and more food can threaten the health of workers involved in the production of pesticides. Pesticides are employed in the industry, they are used in agricultural fields, or they even come into contact with the rest of these materials. Also, medicines which can be effective in controlling a serious disease, can be a threat to the

***Author for Correspondence**
Mohammad Taghipour
E-mail: Mohamad.taghipour@srbiau.ac.ir

[1]PhD Candidate in Management, Department of Management, University of Tehran, Tehran, Iran
[2]PhD Student of Industrial Management, Science and Research Branch, Islamic Azad University, Tehran, Iran
[3]Assistant Professor, Department of Industrial Engineering, North Tehran Branch, Islamic Azad University, Tehran, Iran

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health of workers who are in different stages of drug production or administration. The dangers of chemicals are very wide and from carcinogenic properties to physical hazards such as ignition and environmental hazards. It is different like widespread pollution and toxicity for aquatic animals. Many fires, explosions, and other disasters are also due to insufficient control of chemicals.

Experience has shown that every society has struggled to deal with such incidents, has thought of a solution and followed safety principles before the incident [1–5]. It trains personnel and related people to significantly reduce the number of casualties and provide more security to protect the lives of its personnel. Since it is not possible to achieve 100% safety, it has provided plans with preventive measures and education rather than risk minimization. In this study, we examine the dimensions of the risks of working with chemicals in one of the car manufacturing units of the country, to examine the risk of exposure with these materials.

DEFINITION OF CHEMICAL SUBSTANCE

According to the Convention of the International Labor Organization titled "Safety in the Use of Chemicals in the Workplace" 1991 No. 171, the term chemical substances are defined as the form of elements, compounds and their mixtures with mineral or organic origin, either natural or artificial, such as through production processes obtained. Hazardous chemicals are classified according to the type and degree of their inherent health and physical hazards. The risks of a mixture of chemicals, which consists of two or more chemicals, are determined based on the assessment of the inherent risks of the chemicals that make up the mixture. In addition to the application of science and technology in the production and use of chemicals, by using the available information in a systematic structure, occupational safety and health in the use of chemicals can be achieved.

RISK OF CHEMICALS FOR OCCUPATIONAL CONTACT

Different chemicals have different properties and levels of toxicity. Exposure to toxic chemicals can lead to various effects, the intensity of which will be different according to the way of exposure (respiratory, skin and digestive) and the amount of exposure. In today's terminology, any chemical that causes the occurrence of biological hazards or physical damage to living organisms and the environment is called a hazardous chemical. Chemical pollutants in the workplace include all raw materials, intermediate materials and main products that are used or produced in the industry. These substances, which are in the form of gas, liquid, or solid, may be natural or synthetic and have plant, animal, or synthetic origin (mineral or organic). Each of these substances has its own risks and disadvantages. which depends on the type, way of entry, and amount and duration of contact. In order to fulfill this important task, an assessment should be made of all chemicals that are used in the work environment, through the identification and evaluation of their risks and the adopted control methods. It should be done accurately. It should be noted that in these evaluations only the risk of diseases caused by substances. Chemicals are considered and the risks related to the flammability and explosion of these materials are evaluated using separate and special methods.

In general, the purpose of conducting a chemical risk assessment is [6–9]

1. Knowing the dangers caused by all chemicals that are used, stored or transported in the workplace.
2. Evaluation of employees' exposure to dangerous chemicals through respiratory, skin, and digestive systems.
3. Evaluating the adequacy of available control measures.
4. Specifying tasks that have a high risk for the health of employees.
5. Proposing appropriate control measures to eliminate or reduce risk.

All workers as a workforce should be informed about dangerous chemicals in their work environment and their potential effects on their health and safety. This comes under the evaluation process of the work environment program.

KNOWLEDGE OF EXISTING CHEMICALS

There are three types of chemicals in industries: consumption, intermediate, and production. Each category can be in three forms: solid (particles), liquid, and gas. Suspended particles based on size are in the same group with specific titles due to their proximity in terms of nature and measurement.

Identification of chemicals can be done in the following ways:

- Visiting all places where chemicals are stored or consumed.
- Paying attention to the materials that may be produced during the work process.
- By-products, final products, and all factors that come out of the process such as waste (solid and liquid), waste and unstable compounds.
- Attention to all the materials that are used or arise during operations such as test start-up, repairs and maintenance.

In automobile factories, due to the variety of work operations, a wide range of chemicals are consumed and produced as raw materials and intermediates.

The desired pollutants in this industry are primary and intermediate materials.

1. Consumable materials in the food industry are as follows:
   All kinds of paints, solvents, adhesives, polyvinyl chloride (PVC), zinc phosphate, lubricating oils, resins, acids and alkalis, glass wool, talc powder, cobalt, calcium and titanium salts, phosphate compounds, etc.
2. However, intermediate materials that arise during the work process are:

Types of fumes obtained from welding and soldering (fumes of iron, lead, copper, zinc, titanium, etc.)

Gases from gasoline fuel, CO_2, and SO_2

- Soap water mist during machine operation
- Oil mist caused by induction blinds, electroplating of press molds and welding of oil-soaked parts

THE IMPORTANCE AND NECESSITY OF RESEARCH

With the increasing use of chemical substances in industrial environments and production processes, the pollution of working environments as a result of chemical interactions and reactions on these substances and the release of various pollutants has become increasingly common in the quantitative and qualitative dimension. Therefore, preserving life, reducing vulnerability, describing risks, and awareness of risks, paying attention to the issue of people's contact with chemicals and the health and hygiene of personnel working in industrial environments are among the goals of this discussion [10–14].

RESEARCH QUESTIONS

Research questions are actually the same questions that workers often ask themselves:

1. What is the risk of hazards and injuries of working with each of the available chemicals?
2. How will the damage be?
3. What can be done to protect yourself?

RESEARCH BACKGROUND

Several studies have explored diverse topics across different fields. Research has examined the impact of integrated marketing communication on brand value, the design of safe power outlets, and the influence of inclusive quality management on organizational trust within educational institutions. The relationship between intellectual capital, organizational learning, and employee performance in financial institutions has been analyzed, alongside investigations into the role of ICT tools in evaluating the performance of service organizations. Entrepreneurial marketing has been linked to strategic

planning, while the effect of social media marketing on brand awareness has been studied. The location optimization of industrial complexes using fuzzy decision-making models and the problem-solving of bi-objective hybrid production with advanced algorithms have also been explored. Studies have addressed ergonomic shift work scheduling for nurses, the impact of working capital management on firm performance, and smart management models for chain stores using business intelligence. Additional research has reviewed sustainability indicators in vehicle routing problems, evaluated dam construction management efficiency, and analyzed the psychological effects of color in medical environments. Other work has investigated cloud computing for process control and the influence of physical workplace conditions on employee productivity [15–17].

MATERIALS AND METHODS

The most suitable method for risk assessment is the method based on Topsis (forming a group decision matrix). In this matrix, the criteria and options are placed in the column and row position of the matrix. In this case, Xmn is the value of option m compared to criteria n. However, the owner of the scoring in each criterion originates from the status of the chemical substance, which is defined as a numerical range for each criterion. In the output of Topsis, the final weight of each of the chemicals used is mentioned. This weight indicates the level of risks. This is the substance, and the larger this number, the more dangerous the substance is. The exposure coefficient is calculated by determining the actual exposure level to the chemical substances, when the results of air sampling and monitoring are available, the weekly exposure time. It is estimated using the following relationship:

$E = (F*D*M)/W$

E: weekly exposure rate

F: repeat exposure per week

M: severity of exposure

W: average working time per week (41 h)

D: average duration of each exposure

In this regard, it is assumed that there is no confrontation when the task is not performed. The exposure value obtained from the above relationship is compared with long-term permissible exposure values, then the exposure coefficient is determined through Table 1.

FINDINGS

Types of Exposure of Workers in Different Stations

In all parts of this factory, workers are exposed to dangerous substances in some way: In room making workshops, people are exposed to all kinds of oil mists and fumes from welding, as well as tin fumes from the process of tinning the car body. Fumes can come from metal parts or from welding parts with paint, coatings, cleaners and anti-rusts. that have been used before welding. Metals vaporized in air welding form metal oxide. This oxide cools quickly and creates metallic fumes. Fumes also arise from auxiliary melts or welded metals. The main composition of fumes created from ordinary steel is iron oxide in a relatively low concentration. During the welding of non-ferrous metals such as copper alloys containing beryllium, toxic substances form a large part of the fumes.

These particles are small enough to enter deep into the lung spaces. A common effect of contact with metal fumes is metal fume fever. Metal fume fever is mostly caused by contact with zinc oxide fumes from galvanized steel. Cadmium, copper, magnesium, nickel and tin fumes also cause metal fume fever. Dust: Metal dust is created by cleaning, sanding, and filing the excess part of the weld. This dust can also cause effects similar to fumes on health. The secondary gases produced from the welding process include ozone, nitrogen oxides, carbon monoxide, hydrogen chloride, and phosgene. The protective gases used in welding include argon, helium, and carbon dioxide. Welding operations, which are mainly

carried out in room-making salons, take place in different forms: welding with electricity, welding with acetylene gas, and spot welding. It should be noted that the amount and type of pollutants created by welding in the air of the workplace (fumes, gases, and dust) depends on the type of welding, welded metals, melting aids and fillers, and protective gases. In the paint salon, people are in contact with all kinds of solvents (benzene, xylene, etc.) and people are easily exposed to skin and inhalation exposure. The effects of these factors on health are described in Table 2 [18–20].

But preventive measures that are actually a means of reducing the probability of occurrence of incidents have been stated. These preventive measures after identifying harmful chemicals are as follows:

1. Removing dangerous substances from the work environment and replacing less dangerous chemicals: Because many chemicals have similar properties, it becomes important to choose chemicals that have high efficiency and minimal toxicity to humans.
2. *Engineering controls:* well-designed industrial environments provide minimum contact of the workforce with chemicals. Examples of engineering controls that can be mentioned are: ventilation and humidification systems to control dust) industrial ventilation system design. It is one of the basic measures for the technical protection of personnel.
3. *Doing work safely:* doing work safely will insure all people and chemicals are used correctly and safely.
4. *Personal protective equipment:* masks, eye protection, gloves, aprons and other personal protective equipment and clothes are designed to protect you while working, so use them.
5. Training and communication with occupational health and safety experts
6. *Monitoring the work environment:* professional health personnel regularly make sure that dangerous chemicals do not exceed acceptable contact limits by taking samples from the air in the work environment and collecting other samples.
7. Monitoring personnel and people.

Table 3 shows preventive measures for workers' exposure to chemicals.

Table 1. Determination of exposure factor to chemical substances.

Exposure Factor	Weekly Exposure
1	Less than 0.1
2	0.1 to 0.5
3	0.5 to 1
4	1 to 2
5	Greater than 2

Table 2. Workers' exposure to three chemical substances and their health effects.

Effects	Chemical Substances
Irritation of the eyes, skin, respiratory system, and metal fume fever	Iron fumes
Weakness, pallor, weight loss, malnutrition, abdominal pain, anemia, blue lines on the gums, wrist drop, kidney effects, and eye irritation	Lead fumes
Irritation of the eyes, skin, throat, and nose; dizziness; excitement; drowsiness; coordination issues; nausea; vomiting; and abdominal pain	Xylene vapors
Leads to irritation of the eyes, skin, nose, and throat, as well as shortness of breath	Fiberglass fibers

Table 3. Preventive measures for workers' exposure to chemical substances.

Explanations	Preventive Measures
Personal protective equipment Respiratory protection equipment (respirators) Protective clothing Sanitary facilities and personal hygiene Proper maintenance and care of personal protective equipment as a necessity	Personal protection
Workers exposed to hazardous chemicals should be provided with information about these substances (including labels and safety data sheets), how to work with chemicals safely, what actions to take in emergency situations, and how to obtain additional information	Information and training
Engineering controls should be maintained in optimal working condition.	Maintenance of engineering controls
Measurement methods Monitoring strategy Document recording/record keeping Data analysis and utilization	Exposure monitoring
Medical examinations if necessary Recording and maintaining documents Using the results for the evaluation program	Healthcare
Planning should anticipate the possibility of emergency situations and the methods to address them. First aid must be accessible in the workplace.	Emergency procedures and first aid methods
All incidents must be investigated to determine why they occurred, what deficiencies exist in the workplace, and where the emergency plan failed to work properly.	Investigation and reporting of accidents, occupational illnesses, and other incidents

CONCLUSION

In recent years, significant progress has been made regarding the formulation of laws and regulations and the management of chemical substances, and governments, employers, and workers are trying to reduce the negative effects of the use of hazardous substances both at the national and international levels, but these advances are still not enough. There are still important incidents that have negative effects on both human health and the environment. Workers who are directly exposed to dangerous chemicals must have the right to work in a safe and healthy environment and appropriately taught and protected. In this regard, a list of dangerous substances present in the working environment of people should be prepared and the details of each dangerous substance listed in the list of substances should be described. Containers of dangerous substances must be labeled to identify the substance and to be aware of its potential danger. All workers must be trained to identify and work safely with hazardous materials, and finally, a plan must be developed that links all of the above to each other.

Author Contributions

Conceptualization, MT and MM; methodology, MM and MT; software, MT and MM; validation, MT and MM; formal analysis, MM and MT; investigation, MM and MT; resources, MT and MM; data curation, MM and MT; writing—original draft preparation, MT and MM; writing—review and editing, MM and MT; visualization, MM and MT; supervision, MM and MT; project administration, MM and MT. All authors have read and agreed to the published version of the manuscript.

Conflict of Interest

The authors declare no conflict of interest.

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