



## SAFETY AND RISK MANAGEMENT IN THE RADIOLOGY DEPARTMENT OF THE HOSPITAL AND IDENTIFYING THE SAFETY AND RISK SITUATION WITH FEMA METHODS AND AUDIT ANALYSIS

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### Abstract:

The health and treatment services sector, which is one of the basic sectors of the economy, is a sector with specialized workforce and up-to-date technology that provides various health and treatment services for members of the society. In order to produce and provide services at the appropriate level and quality in this Department, conditions should be provided that are safe from risks and dangers so that the work can be done in a good way. The purpose of this study is to determine the risks faced by employees working in hospitals and the necessary measures to protect them from the aforementioned risks. For this purpose, using a descriptive-inferential method, the specific risks of the radiology department and the general risks in Beheshti Hospital Kashan were calculated and prioritized with two FEMA and audit methods. The results showed that in the radiology department, only the compliance percentage of the occupational health index was in a favorable condition (90.26%) and the highest level of risk in this department is related to eye damage and headache, after which, cases They are related to skeletal and muscular disorders, as well as electrocution, which are at a critical risk level. The results related to the fulfillment of safety requirements in different aspects of the hospital also show that the highest percentage of the fulfillment of the hospital's safety requirements is related to radiation safety (82 percent), which is in a favorable condition, and on the other hand, the worst safety condition is related to safety management, fire safety, respectively. and the emergency response plan of the hospital, which are all less than 50%, which makes it necessary to prevent these risks with systematic management of occupational health and safety.

**Keywords:** risk management, risk control, hospital, occupational safety and health

### 1-Introduction:

The health sector is a complex sector with a matrix organizational structure that has a wide field of activity and a technology-based structure (McDermott et al., 2009). With this complex structure in this sector, the competition of health professionals with time and providing diverse services to diagnose, treat and care for more people in a shorter time may cause them to be under dangerous pressures and risks and make mistakes while harming them. or taking unwanted and undesirable decisions and actions, so health services inherently have a high level of risk (Aksai et al., 2012).

Since this situation may lead to serious crises for a health institution, it is of great strategic importance in terms of influencing the reputation of these health centers such as hospitals and their sustainable success. Therefore, in addition to the risks that have been faced in recent years in terms of human health, the emergence of financial and environmental risks also constitutes another dimension of existing risk that threatens health institutions such as hospitals and medical centers. Therefore,

naturally, health service workers such as doctors, nurses, midwives, pharmacy managers, health technicians, etc., who work in hospital environments, due to the nature of their work, are always exposed to various risks such as: infectious diseases, Chemical and biological poisons, carcinogens, ionizing and non-ionizing rays, and ergonomic hazards occur that seriously threaten the human capital of these organizations (Habibi et al., 2016). This is why working in hospitals is considered as working in a "very dangerous work environment" and the managers of this department are encouraged to carry out extensive studies and follow preventive procedures and measures, while supporting patients and clients. To these centers, to protect the employees and workers of this field from possible dangers and risks that arise in the process of healthcare and treatment. Therefore, in this regard, the risk analysis and assessment process may be seen as a legal requirement as well as creating a strategic advantage for health institutions. For this reason, in this study, while examining the risk management situation in the radiology department of public and private hospitals, the departments exposed to risk are also identified and appropriate solutions are presented to deal with these risks.

## **2- Theoretical foundations and research background:**

### **2-1- General introduction of the health department**

The health sector is a collection of people, institutions and resources whose main goal is to support, renew and ensure human health within the legal framework. Based on this definition, in the health sector, the Ministry of Health, the Ministry of Labor and Social Security and its subordinate units, public and private sector hospitals, medical centers, family medicine and community health centers, health centers, health insurance services, voluntary organizations. and private health-related, pharmaceutical industry and drug marketing companies take place (World Health Organization, 2023).

### **2-2- Dangers and risks in the health sector**

In many areas of health services, especially in hospitals, there are important risk factors in terms of occupational health and safety. There are five basic risks that affect the health of health care workers in the hospital environment. These risks are: biological, physical, ergonomic, chemical and psychosocial. The National Institute for Occupational Safety and Health (NIOSH) classifies 29 physical hazards, 25 chemical hazards, 24 biological hazards, 6 ergonomic hazards, and 10 psychosocial hazards. These risks reduce work efficiency, economic losses of the institution, increase work accidents for health workers and expose them to direct risk. For this reason, it is necessary to ensure that the working environment of health workers is suitable for health conditions and to eliminate risk factors (Ozkan, 2006).

#### **2-2-1- Physical risks and threats**

##### **2-2-1-1- Audio risks and threats:**

Noise is defined as annoying and unwanted sound that is the product of sound waves consisting of rapid vibrations in the air (National Institute for Occupational Safety and Health, 1988). Exposure to high levels of noise is one of the most common occupational hazards. Temporary and permanent hearing loss can be observed by increasing the level of exposure and prolonging the duration. Even if hospitals are considered quiet places, in the research conducted, the amount of noise in the power plant, laundry, dishwasher, kitchen, printing house and maintenance and repair departments where electrical machinery and tools are used, such as: rehabilitation units, electrical surgical tools Orthopedic alarms and monitors exceed 80-85 dB(A) and reach up to 110 dB(A) (International Labor Organization, 2014).

##### **2-2-1-2-thermal comfort**

If the temperature of the working environment is higher or lower than necessary for the thermal comfort of the person, it leads to unfavorable conditions. Thermal comfort is provided at temperatures of 20-22°C in winter and 20-24°C in summer. Places such as laundry, heating and kitchen are known

as hot environments. Other parts of the hospital may also be hot during the summer months. This situation is observed especially in old buildings that do not have proper ventilation, heating and cooling systems (National Institute of Occupational Safety and Health, 1988). The adverse effects related to this risk include heat stress, heatstroke, heatstroke, fainting, and skin rashes. (National Institute of Occupational Safety and Health, 1988).

### **2-2-1-3- Insufficient ventilation**

Ventilation systems are important for any building and should be designed to provide the right temperature and humidity. Ventilation systems are also important in hospitals. Hospitals are environments where the risk of infection is high. In order to maintain the health of patients and staff, ventilation systems in hospitals must be designed to prevent infection. The coolers used in these areas should also be selected in such a way as to minimize microorganisms, dust, anesthetic gases and odors. Among the units that need special ventilation, we can mention things like: operating room, sterilization unit, laboratory and pharmacy (Parlar, 2008).

### **2-2-1-4- Rays:**

Radiation is the emission of particles that make up atoms or the release of energy in the form of electromagnetic waves (Peterson et al., 2007). Radiation was discovered in the late 1800s and one of its first uses was medicine. Radiation, which is very useful in diagnosis and treatment in terms of human health, can be found in most health institutions. But along with its benefits, its harms have also been discovered, and it is necessary to know the types and risks of radiation and take the necessary precautions to protect health workers from these harms. X-ray machines and closed and open radioactive sources are widely used in hospitals (Tadese, Adamasu, 2009).

### **2-2-2- Chemical risks and threats**

Chemical substance refers to any element, compound or mixture that is in its natural state or is produced or is created during any process or as waste or is formed accidentally. In studies, it has been determined that about 299 different chemical components in the form of dust, vapor, gas and liquid harmful to human health are found in health institutions (Reddy et al., 2010). Chemical hazards frequently encountered by health care workers include detergents, disinfectants, anesthetic gases, sterilizers, chemical disinfectants, and drugs. Therefore, health care workers are usually exposed to various chemical hazards that sometimes cause work-related dermatitis and asthma. Acids and alkalis, salts, dyes, volatile organic solvents, various drugs, especially anti-neoplastic drugs used in pathology, biochemistry, hematology and other laboratories are important risk factors for causing a number of diseases from allergies. are up to cancer (Wilborn, Eckmans, 2004).

### **2-2-4- Risk and biological threats**

Basically, microorganisms, cell cultures and human internal parasites, including genetically modified parasites that can cause infection, allergy or poisoning, are defined as "biological agents". Healthcare professionals may be exposed to biological hazards such as bacteria, viruses, fungi, or parasites transmitted from sick individuals or contaminated body fluids or secretions. These factors are dangerous for the personnel of this department in almost every unit, which can cause skin inflammation and allergic reactions, respiratory diseases and other infectious diseases if the necessary precautions are not followed. Studies have shown that the risk of infection in health care workers is higher than other workers (Tadese, Adamasu; 2006).

### **2-2-5- Ergonomic risks**

Ergonomics is the science of creating suitable working conditions and working environment for employees. According to another definition, ergonomics is a method for understanding the complex relationship between people, machines and job demands and minimizing the gap between human capacity and job demands in daily life and work activities used. Is. Work-related musculoskeletal

diseases can occur in hospitals when there is a mismatch between the physical demands of the job and the worker's physical capacity. Basically, sanitary places are environments where there are ergonomic hazards (Occupational Safety and Health Administration, 2023).

### **2-2-6- Dangers and safety risks**

There are many safety hazards in hospitals such as falling, being hit, contact with sharp objects, contact with very hot or very cold objects, fire and explosion. In these places, due to the nature of the services produced, the crowding and the speed of work cause that sometimes due to the presence of wet or uneven floors, people fall more often and hitting an object can cause a sudden fall. Cleaning bathrooms and toilets in wet units such as kitchens, dishwashing rooms, laundry rooms and clinics are common hazards. Working with medical instruments in the operating room, actions such as stopping bleeding, injections, access to vessels, dressings in clinics and polyclinics, and broken or cracked glass materials in laboratories can cause injury with cutting and splitting tools (I Gunn, 2007). The risk of electrocution can be fatal to staff and patients. Due to the engineering structure of these buildings and the multitude of electrical devices used in hospitals, all hospital employees are at risk of electric shock and fire (International Labor Organization, 2014; National Institute of Occupational Safety and Health, 1988).

### **2-2-7- Psychological dangers and risks**

In the health and treatment sector, they are forced to work for a long time during the service due to many reasons such as heavy workload, care of severe and incurable patients. In addition, because of the need to provide emotional support to patients and their relatives, it causes tension and stress caused by work. In addition to these, inadequacy in health services and imbalance in the distribution of services and personnel lead to loss of motivation and work depression in employees. Job stress and burnout can be psychological; Such as depression, anxiety and feeling helpless, which can cause physiological effects such as headache, muscle tension, insomnia. Studies have determined that health workers are one of the high-risk groups in terms of job burnout and psychological risks (Karovski et al., 2005). The National Institute for Occupational Safety and Health (2008) defines occupational stress as "harmful physical and emotional reactions that occur when job requirements do not match the abilities, resources, or needs of the employee", which is one of the most important psychological risks. It is in the health sector.

### **2-3- Risk control decision-making methods of health institutions and conducted studies**

According to the requirement and necessity of risk management and control in health and treatment sectors, various methods have been proposed by researchers, which can be used in the decisions to control risks determined in high-risk areas, eliminate risks or reduce their effects, and in short, in the program used risk management. We can briefly name these methods as follows (Aidin Lee, 2010; Gulj, Gokman, 2009): Failure and Effect Analysis (FMEA), Principal Component Analysis (RCA). , Hazard and Performance Study Method (HAZOP), Zero Defect Program (ZFP), Pareto Analysis, Fishbone, etc., Audit Methodology, Problem Solving Approaches, Six Sigma, Quality Circles, Statistical Quality Control (SPC), Performance Deployment Quality (QFD).

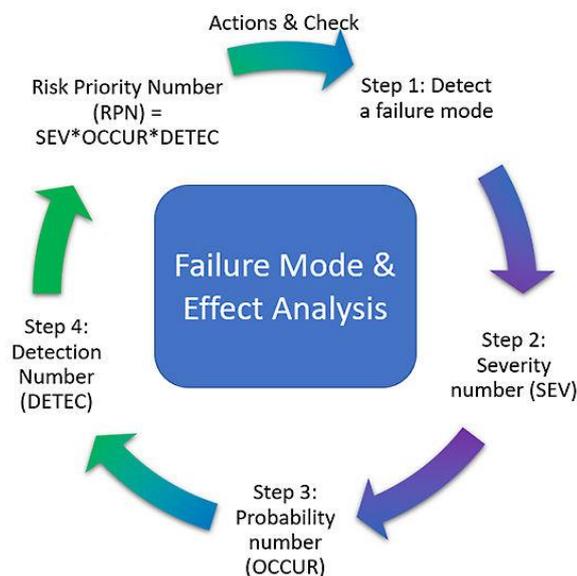
Among the internal studies conducted in this field, we can mention the study by Habibi et al. (2013) which was conducted in the radiology department of Isfahan hospitals The results of this study show that none of the hospitals are in a good safety condition and about half of these hospitals are at an average level and the rest are at a poor level. In another study by Fathi (1381) in the Kurdistan University of Medical Sciences hospitals, out of the total of 10 investigated hospitals, only one hospital's safety status is satisfactory. Mousavi et al.(2009) in the study of Radiology Department of Tehran University of Medical Sciences Hospitals, have concluded that these hospitals are relatively safe in terms of patient safety and dealing with fire. Nowrozi et al.(2013) in a study in teaching hospitals of Shiraz University of Medical Sciences concluded by audit method that the average percentage of the fulfillment of safety requirements in all the hospitals studied was 58%. The highest

and lowest fulfillment of safety requirements is related to radiation safety and safety management, respectively. In another study, Abbasi et al. (1400) investigated the safety and risk situation of Imam Khomeini Hospital in Ilam and acknowledged that the highest level of risk in this hospital is related to improper posture and musculoskeletal disorders, and after them Improper electrical and lighting panels were also in the critical risk stage.

### 3-Research methodology:

This study is a descriptive and inferential type that is combined and cross-sectionally conducted in two stages in the winter of 1401 in the radiology department of Beheshti Hospital in Kashan. In the first stage, the safety and risk management situation of the radiology department was investigated using four standard checklists of occupational health (including 19 questions), electrical safety (including 68 questions), fire safety (52 questions), and personal protective equipment (23 questions). They will be. The validity of the checklists was confirmed by three experts in the field of safety. The obtained results will be divided into four levels: poor (less than 50), medium (between 50 and 75), and good (between 75 and 100). In the prepared checklists, one point was assigned to each question, and if the desired conditions were in accordance with safety standards and requirements, one point would be assigned to that question, and zero points would be assigned to that question otherwise. In the continuation of this stage, the risk assessment will be carried out using the FMEA analysis method of violation situations and its effects. In this method, there will be three main parameters: intensity of the message, probability of occurrence of the consequence, and probability of discovering the consequence. The severity of the message means the amount of damage to humans, damage to national assets and the environment, etc. The probability of occurrence also means determining the probability of the outcome, which is divided based on the duration of the incident and the frequency of repetition. The probability of discovering the result also means specifying the probability of discovering a type of assessment of the system's ability to identify a cause or mechanism of risk occurrence. The risk priority number (RPN) will be obtained by multiplying the degree of severity, the degree of occurrence and the probability of discovery, which can fluctuate between zero and 1000. Using this index, the risk level can be divided into three groups with low crisis (RPN=1-99), medium crisis (RPN=149-100), and high crisis (RPN=1000-150) (Abbasi et al., 1400).

FMEA generally consists of six stages along with the control stage and its cycle is presented in Figure 1. The stages of the cycle include determining the type of error, determining the severity coefficient, determining the probability coefficient, determining the detection coefficient, calculating the risk priority number and control.

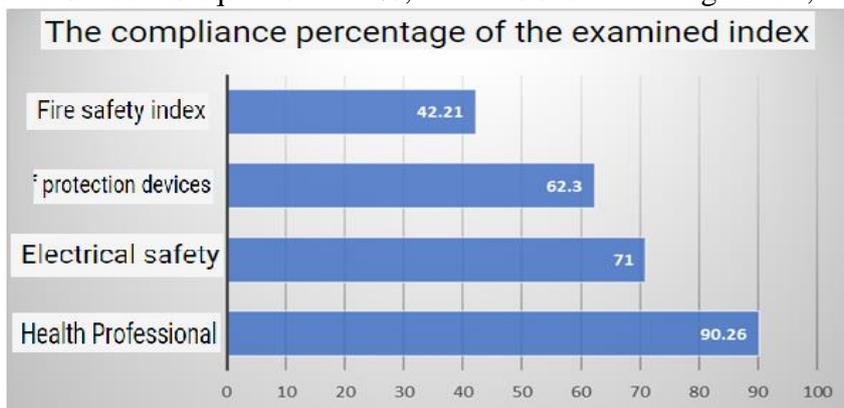


**Diagram 1.** Work cycle of the FMEA method

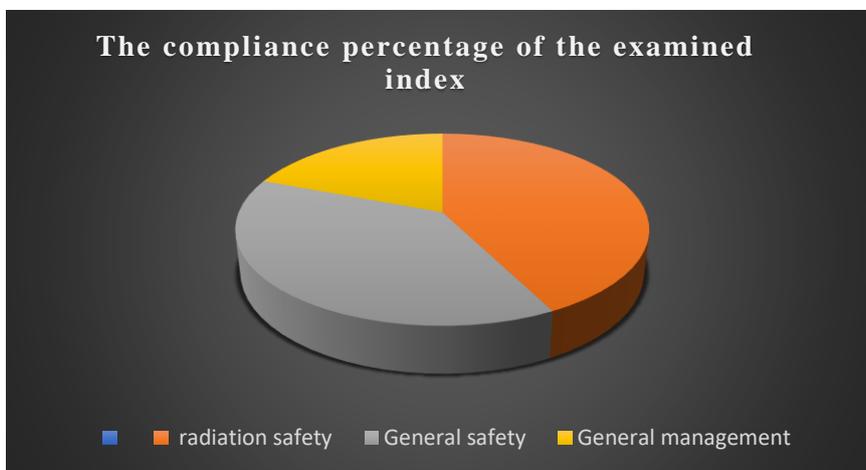
In the second part of the study, using the audit analysis method, audit checklists are prepared and the required data are collected through observation and interviews with managers and officials of different departments of the hospital, as well as document review. Finally, the safety status of the whole hospital is classified according to the degree of fulfillment of safety requirements in three levels: weak (less than 50%), medium (50-75%) and good (75-100%). The checklists of this stage had a total of 120 questions, of which 6 questions were related to safety management, 35 questions were related to public safety, 19 questions were related to electrical safety, 24 questions were related to fire safety, 16 questions were related to radiation safety, and 20 questions were related to the response plan. Emergency conditions were reserved. The validity of the checklists was confirmed again by three experts in the field of safety. At this stage, each question is assigned one point, and if the audited conditions are in accordance with safety standards and requirements, then one point is given to that question, otherwise, zero point is given to that question. Finally, the percentage of safety requirements for each subject is calculated by dividing the number of points obtained by the total number of points multiplied by 100.

**4-Research findings:**

The results of the investigations in the radiology department showed that among the investigated indicators, only the compliance percentage of the occupational health index was in a favorable condition (90.26%) and the electrical safety indicators with a numerical value of 71% and the equipment index Individual protection with a value of 62.30% is in an average situation. Finally, there is the fire safety index, which unfortunately is not in a good condition and is in a weak area. The numerical value of this index is equal to 42.21%, which is shown in diagram 2a, 2b.



**Diagram 2a.** The percentage of compliance of the examined index with the favorable condition of the radiology department of the hospital



**Diagram 2b.** Pie chart the percentage of compliance of the examined index with the favorable condition of the radiology department of the hospital

In the continuation of the work and according to the risk assessment (Chart 3) in this part of the hospital, the highest level of risk is related to eye damage and headache. After this, the cases related to skeletal and muscular disorders as well as electrocution are at the critical risk level. At the medium risk level, risks such as not controlling temperature and humidity and not controlling microbial and chemical infections; And at the low risk level, there are things like mental effects, nausea and vomiting, dry skin and cough. Therefore, according to these cases, it can be stated that in order to manage the risk and reduce the listed risks, it is necessary to immediately carry out control and intervention measures for medium and high crises. The results of this section are shown in Table 3.

The exact amount of risk of each damage in the order of risk from high to low are:

- A: Eye damage and headache with 366 risk
- B: Muscular, skeletal disorders with risk 324
- C: Electric shock with 310 risk
- D: Cancer and infertility with risk 291
- E: Fire with a risk of 280
- F: Fatigue and lack of concentration with risk 247
- G: Reluctance to work with risk 231
- H: Anemia with risk 205
- J: Failure to control chemical and microbial infections with risk 146
- K: lack of temperature and humidity control with risk 113
- L: mental effects with risk 91
- M: Nausea and vomiting with a risk of 80
- N: dry skin and cough with a risk of 72

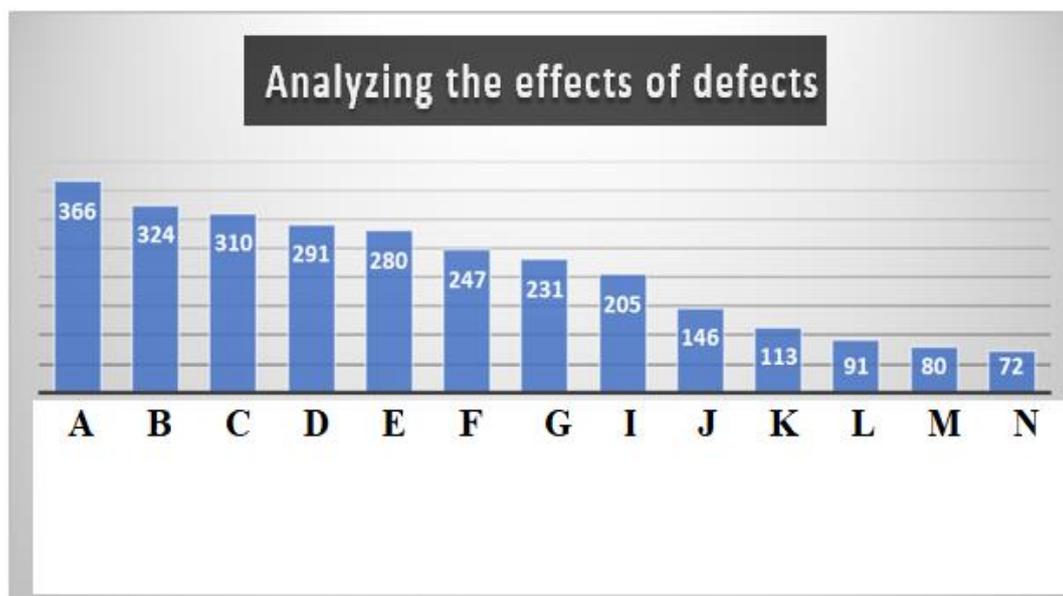
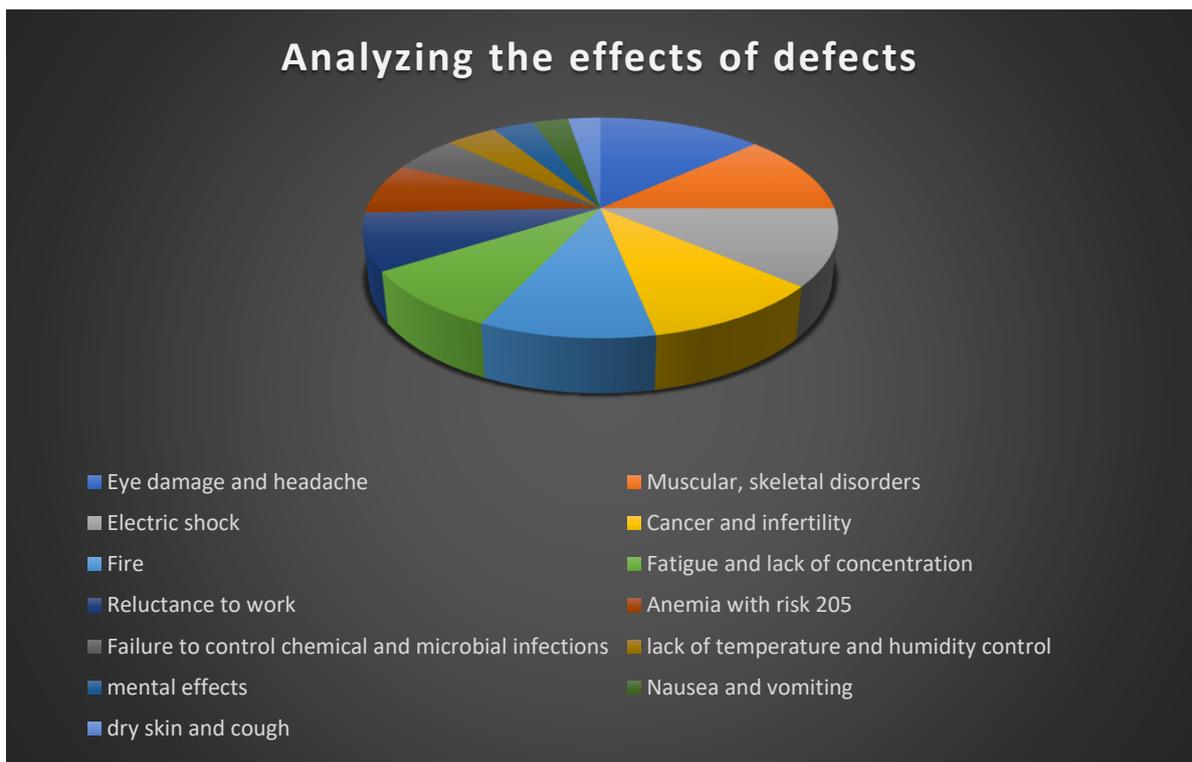


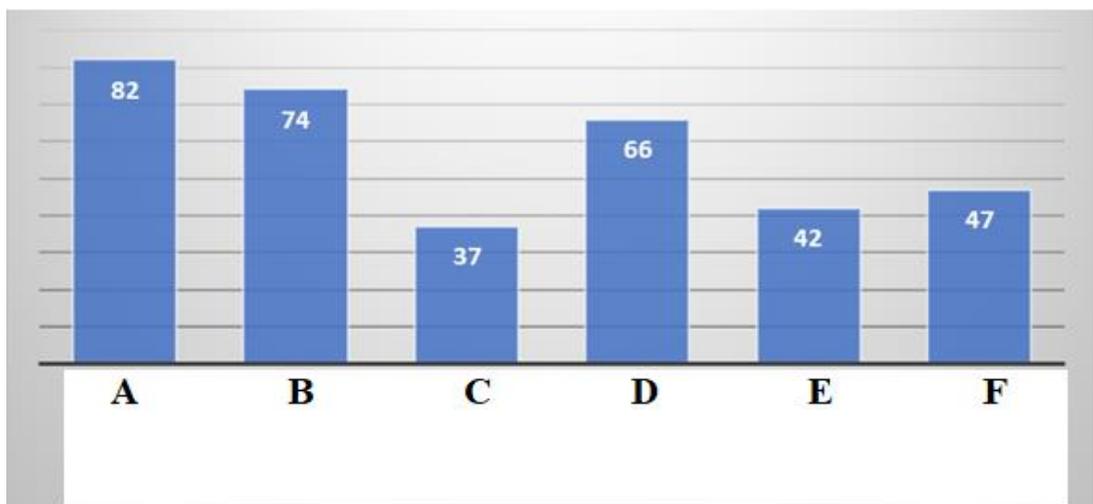
Diagram 3a. Analyzing the effects of defects



**Diagram 3b.** Pie chart Analyzing the effects of defects

The findings of the second stage for checking the fulfillment of safety requirements in various aspects show that the average percentage of the fulfillment of the hospital's safety requirements in the year under review is 58% with a standard deviation of 17.50. According to diagram 4, the highest percentage of fulfillment of safety requirements is related to radiation safety, which is in a favorable condition. As it can be seen, an average situation in public safety and electrical safety has been observed (between 50 and 75 percent) and finally the worst safety situation is related to safety management, fire safety and emergency response plan of the hospital, respectively, which are all less than have become 50 percent.

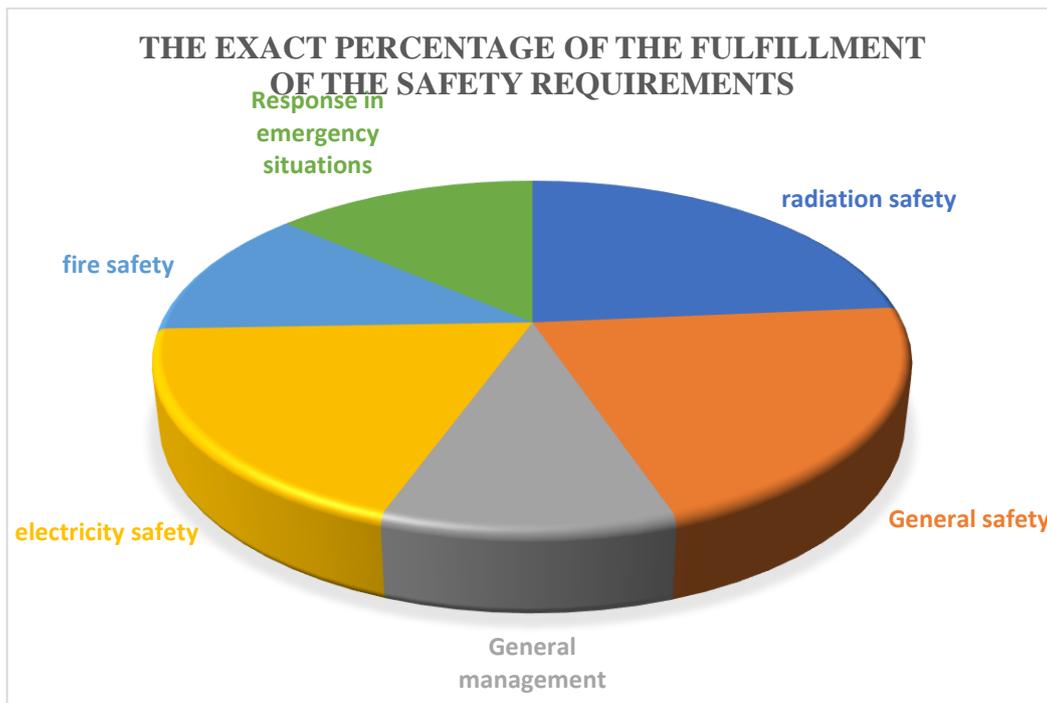
Therefore, it seems that the most important reason for this issue is the lack of clear responsibilities and the lack of organizational structure in the field of occupational health and safety issues in hospitals, which requires the occupational health and safety management system (OHSAS 18001) as the most effective. The executive solution should be established in hospitals.



**Diagram 4a-** The percentage of fulfillment of the requirements of various safety issues

The exact percentage of the fulfillment of the safety requirements of various safety issues in Beheshti Hospital Kashan is as follows:

- A: 82% radiation safety
- B: General safety 74%
- C: General management 37 percent
- D: 66% electricity safety
- E: 42% fire safety
- F: Response in emergency situations 47%



**Diagram 4b-** Pie chart the percentage of fulfillment of the requirements of various safety issues

### 5-Conclusion:

Today, hospitals are one of the most important advanced treatment centers, which are very important from an economic, human and moral point of view. For many years, due to the existence of inherent dangers and risks in the activities of this category of healthcare organizations, the observance of safety and health principles has been given special attention in them, and it is emphasized that the observance of these matters leads to an increase in the effectiveness of the activities, efficiency and finally productivity increases.

Therefore, while providing a safe environment to maintain the health of patients and employees, hospitals should have the necessary preparations to fulfill their mission in the event of an emergency without jeopardizing the health and safety of their employees. spread in their organizational units. The results of this study, which was carried out in the same direction, showed that in the radiology department of Beheshti Hospital, Kashan, among the investigated indicators, only the percentage of conformity of the occupational health index was in a favorable condition (90.26%) and the indicators Electricity safety with a numerical value of 71% and the index of personal protective equipment with a value of 62.30% are in an average condition, and its fire safety index is equal to 21.42%, which shows its inappropriateness. The supplementary result of investigations in this part of the hospital showed that the highest level of risk in the radiology department of this hospital is related to eye damage and headache. After this, the cases related to skeletal and muscular disorders as well as electrocution are placed at the level of critical risk, which requires management to take measures to control them. The results of the second part of this study also showed that the whole hospital has a good condition in terms of radiation safety, which is of great importance for the health of personnel,

and about 82% of the requirements related to radiation safety have been achieved. Therefore, the relatively favorable state of compliance with radiation safety requirements in the radiography and radiology departments of the investigated hospital can be attributed to the existence of the strict regulations of the Atomic Energy Organization and the supervision of the health physics officer on these departments. From this point of view, the findings of the research are consistent with the studies of Fathi (2011) and Nowrozi et al. (2011).

In the sector of public safety and electrical safety, which have achieved 74% and 66%, respectively, it is in a relatively favorable area, it seems that due to things such as the lack of a program for risk assessment and management, monitoring and safety inspections, recording and reporting of accidents and quasi-accidents, lack of preparation of safety instructions, warning boards and signs, safety training and safety plans and programs, lack of regular safety committees, etc., which has caused a very favorable situation in this. If there are no accidents, if they are solved, we can hope to increase the realization of public safety.

Among the major weaknesses and problems of the Mor Estadu hospital, we can mention safety management, fire safety and emergency response plan, which have been observed in similar studies in other hospitals. Therefore, in general, it can be attributed to errors such as: lack of an effective plan to respond in emergency situations, failure to predict emergency exit routes for different hospital units, lack of clear main escape lines and exit routes, lack of training of employees in performing appropriate response in emergency situations. He pointed out that some of the emergency exits are closed and the emergency exits are insufficient, which causes the percentage of the realization of these three important safety measures to be low. Therefore, the findings of this section are consistent with studies such as Allahvardi et al. (2015), Daneshmandi et al.

Therefore, according to the results of this study, it is suggested that while using systemic thinking in identifying risks and errors in the health and treatment sector, the use of different risk management methods should be prioritized and the use of the occupational health and safety management system. 18001 OHSAS) in all hospitals, and conducting comparative studies with other scientific methods, prevented the increase of risk and life and financial risks in hospitals and healthcare centers.

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