Identifying Job Risks Related to Overhead Cranes with the Help of Job Safety Analysis and Making Decisions about Them Based on MADM

Behzad Bafkar
Master of Cartography
Jahan University of Isfahan

Zahra Naserzadeh
A member of the faculty of the Hse engineering department and the industrial safety engineering department of Allameh Qazvini Institute of Higher Education, Qazvin, Iran

Narges Asadi
Master of HSE Engineering

Abstract

The health of work locate and safety of people that deal with overhead cranes is important; and operation with overhead cranes encounter with many accidents. As a point, this study presents a new investigation in the area of work risk examination connected to overhead cranes by combining two JSA job safety analysis methods and MADM multi-criteria decision making model. This research as a descriptive-survey study investigate the associated risks of the overhead cranes in Hami Alloy Asia Steel Company by blending JSA and AHP methods. The method of gathering information encompasses interviews with operators and other people deal with this device, considering the records and documentation of the incident and identification of accidents, as well as observation of work process with the crane; and Analyzes performed by the Expert Choice software. The results exhibit that the injured current cables and course spread, isolation damage and current spread, as well as non-operation of sirens, levers, and pedals classify first to third amongst the risks link to overhead cranes, respectively. In addition, the putrefaction of the gears, the hard displacement of the gear, and the decrease in production efficiency take the twelfth ranking. The compatibility rate ascertains usage of the Expert Choice software in pairs of comparisons the options match in 0.031 that specify an excellence compatibility of the contrast. The present study showed the JSA technique is a definite and systematic technique to define and measure the existing or potential risks in each job and procedure, and in mixture with the AHP technique, it can successfully identify and prioritize the risks related to overhead cranes.

Keywords: overhead crane, risk assessment, JSA, AHP, MADM

Literature

Today, through the proceeds of science and technology, humans are exhibited much hazards. Occupational health and safety is mentioned in matters rely on the protection of employee and workshops, reduction of the occupational accidents amount, minimizing insufficient details and improving employee awareness. Newly, one of the most critical processes of occupational health, safety administration, risk assessment and management has been gained great importance due to some regulative and licit measures; due to the fact that technology advancement, the existence of alternative types of hazard identification and risk assessment methods, it is possible to ascertain the critical and accident-prone points before accidents happen, prevent and command them. In fact, safety management is organized risk management institutions and industries, and includes a process of the determining policy actions, scheme, organization, planning and evaluating efficiency and correction activities; identifies sources of risk and determines control measures before harm occurs; This is included identifying hazards, deciding someone might be harmed and the reason of damage, assessment of dangers and deciding on precautions, recording serious findings, furthermore reviewing and updating assessments as required. Avon et al., 2016 were conducted an extensive review of current developments in risk appraisal and management with a special concentration on primary ideas and thoughts. Considering the importance of health and occupational safety of people that deal with overhead cranes in workstation, a little mistake can be caused irreversible damages; these equipment activities range in industries, identifying the potential mistake, evaluating and providing appropriate answer to reduce the risk of such errors is incontrovertible. Due to the common incidents of job with overhead cranes and the fact that no study has been performed in the sphere of job risk analysis related to overhead cranes by merging the two methods of JSA job safety analysis and MADM multi-criteria decision making model, this study identify occupational danger rely on overhead cranes with the assist of job safety analysis method and MADM risk assessment technique. One of the reliable tools in the field of risk assessment and prioritization according to the opinions of experts is the multi-indicator decision-making methods of MADM; the benefit of this method are deemed all the criteria related to various weights and exchange among them, and providing real results. In fact, the MADM method can be used to weight risk elements and enhance the performance of the system (Yousef, D. A. 1998). On the other hand, the JAS method, one of the most substantial management tools helps to eliminate risks and lessen injuries and incidents in the workplace. Further, the risk identification in the completed production process can be retrained the workers, and JAS productivity and efficiency will be increased. According to the statistics posted by the International Labor Organization, every year 1.2 million people in the world are killed due to occupational accidents (roughly 250 million) and illness (roughly 160 million) in different parts of the world, and the economic loss of these accidents and diseases is approximately four percent of the global gross national product. The conducted researches were specified the steel industry records the most occupational damage and accidents, in addition, one of the occurrences resource of occupational hazards was the overhead cranes. Cranes were the main equipment in the process of moving loads, and the principal reason of accidents in manufacturing and building sites (Roshan et al, 2015). Unfortunately, exact statistics of the total incidents with overhead cranes in Iran are not accessible. According to statistics, the number of occupational injuries in 1998 was about 9,996 accidents, 97.2% of it relied on men and 2.8% of women. However accurate statistics of how many of these occurrences were related to overhead cranes was not available (Borgheipour et al, 2020). According to the statistics of the United States Institute of Occupational Safety and Health (NIOSH) connected to the accidents of alternative types of cranes throughout the years 2002 to 2012, the highest amount of accidents was overhead cranes and the load falling on the operator with 42% of death; furthermore, the safety standards were recommended preventive measures for the workers of this risk. According to the Labor of United States Department statistics in connection with the examination of crane accidents in 2014, overhead cranes amongst other cranes were represented in 52% of the most important cause of death and the risk of the load dropping on the operator. This necessity was required serious consideration of the safety standard related to the load carrying activity in overhead cranes. Research demonstrated that falls account for roughly 33% of all deaths. Being struck by an object was another 11%.

Electrocution happened in 36% of fatalities. Entrapment between tools and other problems resulted 20% of deaths [3]. Person mistake was the serious reasons for accidents linked to cranes (Roshan et al, 2015).

According to the above statistics, it is highly important to the concentration of seriously on job analysis as a point of safety and health hazards, mostly in high-risk industries. Thus, it is necessary to classify our HSE aim and scheme for all businesses by determining risks and creating preventive measures. In this way, the further correct risk identification accomplishes the superior system performance. Since 1930, Job Safety Analysis (JSA) has been implemented in industrialized countries as one of the accident prevention and risk analysis models. The occupational safety examination is a systemic method for application of its own technique vocational procedures that collects and organizes data for proper decision-making resolution in a different operation situation, and uncover the reason of work-related injuries and damages. In reality, the work risk analysis device is focused on a particular job and determine the task necessity to render each job, and eventually specify the steps forward performed tasks, in addition, their risks are identified in order to prevent possible accidents (Gholi Pour et al, 2017).

The best labor method for task safety analysis is the job safety test execution method provided by OSHA accredited organizations within the OSHA3071 standard. Disclosed to the OSHA's view, effective job safety analysis has prevented many injuries and diseases. Furthermore, the OSHA has considered job analysis as one of the important elements of occupational health and safety management (Jafari et al, 2010). Risk detection and hazard assessment are an organized method for identifying and prioritizing risks. All the activities of industrial units need requirements that the less attention to it has led to possible adverse consequences for personnel, internal and external clients, processes, goods, amenities, atmosphere, organization credit and other assets. Therefore, risk assessment is important methods of targeted control of hazard in the industry that has been investigated at various levels and dimensions of a labor process (Kouhnavard et al, 2015).

JSA is a detailed and systematic examine technique to identify and assess available or potential hazards in each job and process. This method, relying on aspects of industrial safety and health, is the most workable in the execution of all work activities (Esposito,). In fact, it is a preventive method to pinpoint occupational hazards and has reached to the assurance of the acceptable level of safety and health in the place of work and eventually, has been determined control measures for the risks of this job. The consequence of the occupational safety assessment (JSA) can be used in training and the education needs assessment of employees in industries. The main goal of JSA risk assessment is contained to find a safe way to proceed the job and prevent occupational accidents. The main goal of JSA risk assessment is contained finding a safe way to proceed the job and prevent occupational accidents. The story of the implementation of the JSA technique in commercial countries dates back to the 1930s and before (Ericson,2015- Ebrahemzadih,2016- Roughton,2011- Yousef,2017- Mohammadi,2011). The job hierarchy of this technique is identifying the risks of each stage of the labor, tasks and sub-tasks, and calculating the risk number, and providing control solving (Ebrahemzadih 2016).

The most critical advantages of the JSA technique are contained the least requirement of human and fiscal resources, and minimal equipment and facilities in the implementation of mode. The JSA method is simple, widely used and the Prevention methods of accident prevention and risk analysis. This method is the most essential management device available that has assisted to eliminate risks and has reduced injuries and accidents in the work atmosphere; the JSA can be increased productivity by defining errors in production procedure [۱۳]. Completed JSA forms can be used to retrain staff and train new staff and to investigate the cause of incidents. Most importantly, JSA allows employees to participate in the process and share their expertise with others. With this method, the type of work performed by the employee must first be fully understood and recorded in writing. In fact, JSA managers must know the production line, processes, jobs, etc. in an industrial environment (Halvani, 2016). Therefore, a thorough and preliminary investigation is the first step. The work a worker performs today may be different from the duties performed on other days, or the same work may be performed under different physical and environmental conditions. Perhaps this is one of the reasons why it is necessary to involve the worker in the process. In general, JSA is a method used to analyze work methods and to clarify them and to identify risks that may occur in the organization of the workshop and the design of equipment, work centers and processes based on residues or after starting a job due to a job products made or caused by It is used to change work methods or workers (Rezaei, 2017). The most important part of developing any occupational health and safety program is risk identification. Danger Identification of Improved System Performance

(Ebrahemzadih, 2016). Identifying and prioritizing risks allows managers to minimize their consequences According to experts, one of the most reliable risk assessment and ranking tools in the field of risk management is the MADM multi-indicator decision-making method. One of the advantages of this method is to take into account all the criteria related to the different weights and the exchanges between them, finally giving real results in this area. In fact, it is the MADM method that can be used to weight between risk factors and improve system performance (Yousef, D.A1998).
The AHP hierarchical analysis method is a method of a subset of MADM methods used in many studies, which is used for weighting and prioritizing indicators, decision making, and selecting an option from a set of decision options. According to the indicators determined by the decision maker. This method was invented and introduced by Thomas Satie in 1980. Hierarchical processes reflect natural behavior and human thinking. This technique examines complex problems based on their interactions and transforms them into simpler forms and solves them (Parvin, 2007).
This method was developed (by Sonny in 1980) to support multiple decisions. In this sequence, after mapping the characteristics of a set of security risks, a comparison matrix is made of the parameters (survival chances, health risks and financial risks) related to each other. In this way, the dangers and risks of overhead cranes are compared to each other and a comparison matrix is created. Then use this matrix to calculate the relative weights of the elements. The objective of the Hierarchical Analysis process technique is to select the best options based on different criteria through pairwise comparison. This technique is also used to add weight to the threshold. As the number of components in each cluster increases, pairwise comparison becomes difficult, decision criteria are often divided into sub-criteria (Schulte, 2005).
Based on what was said, this research seeks to identify the occupational hazards of overhead cranes through occupational safety analysis and make decisions about them based on the MADM of Hami Asia Alloy Steel Company. Given the importance of occupational health and safety in overhead cranes and the high frequency of crane accidents, several studies have been conducted to analyze occupational risks. A combination of two job security analysis methods, JSA and MADM multi-parameter decision model was not considered, Therefore, we decided to carry out a study with the aim of "identification of work hazards associated with overhead cranes with the help of the safety analysis method and MADM risk assessment technique" so that by evaluating and prioritizing the work hazards associated with these machines, we can minimize and Mari takes steps to control the risks and accidents caused by working of it.

Research Methodology

This research is a descriptive-survey study premised on the purpose of an applied research. These researches were utilized by using the background provided in basic researches to meet human needs and improve and optimize methods to develop well-being and improve the level of human life.

In addition, based on the nature and method (the way to obtain the necessary data), the current research is among the descriptive surveys of the survey type. In terms of type of supervision and degree of control, this research is in the category of field research because the researcher examines the variables in their natural state.
The statistical society include the operators involved and others handling this device. It should be noted that the number of 4 cranes of the Asia Alloy Steel Company is included in the statistical society.

The sample in this study includes an overhead crane from the Asian Alloy Steel Company.
As the first step of the research, the information and total number of existing cranes in Asia Alloy Steel Company were studied and recorded. 4 overhead cranes were identified, and one crane was selected as a sample. Then, using the method of interviewing the relevant operator and other persons interested in these machines, as well as examining the records and documents related to the occurrence and description of the accidents, the necessary information was collected and the different processes of working with the overhead crane were defined. In the next step, after identifying the work steps on the overhead crane, the associated hazards were investigated using the Job Safety Analysis (JSA) method. Risks related to overhead cranes are prioritized and finally the results of job safety analysis

methods are used to include hierarchical process analysis techniques. Using the AHP method, which is one of the most widely used methods in multi-criteria decision-making, hazards are identified and health and safety risk assessments are carried out in the overhead crane. This method is one of the most comprehensive methods designed for many decisions; this method includes different situations in decision-making and has the ability to analyze sensitivity to criteria and sub-criteria, in addition, it is based on pairwise comparisons, which simplifies decisions and calculations. It shows the degree of decision consistency and inconsistency, which is one of the advantages of this method over multi-criteria decision-making.
On the other hand, it provides the possibility to formulate the problem in a hierarchical way and also the possibility to consider different quantitative and qualitative parameters in the problem. The basis of this decision-making method is based on pairwise comparison. The decision maker begins by building a hierarchical decision tree. The decision hierarchy tree shows the factors that are compared and the competing options that are evaluated in the decision. A series of pairwise comparisons were then performed. The comparisons show the weight of each of the factors in line with the competing options evaluated in the decision. Finally, the logic of the hierarchical analysis process combines the matrix resulting from pairwise comparisons with each other so that the best decision is obtained.
Job safety analysis and risk assessment were performed with the JSA method and risk matching with the two AHP methods.

Results

In the present study, firstly, a hierarchical analysis of the work tasks of overhead cranes was carried out using the HTA method, as well as an analysis of work processes and interviews with the overhead cranes operators. All the activities of the overhead cranes were taken and finally the top crane HTA was drawn as Figure 1-4.

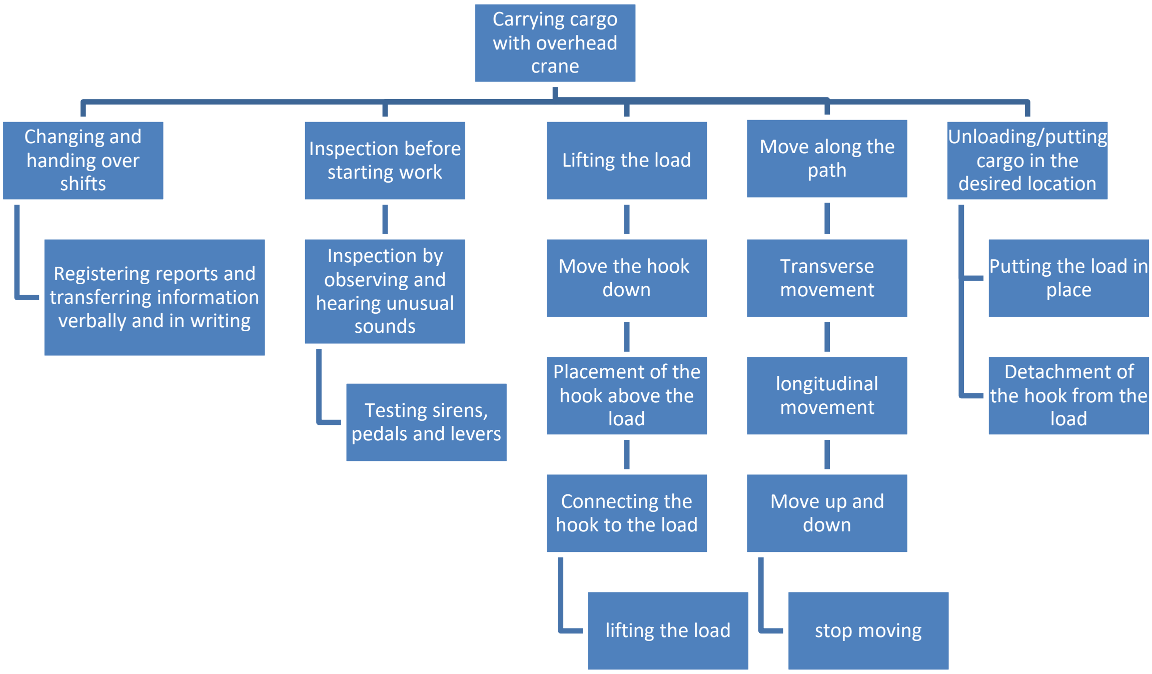

Figure 1-4 HTA cargo handling with overhead crane

As shown in Figure 1-4, overhead crane handling consists of 5 main tasks including shift assignment (one sub-task), overhead crane pre-inspection (two sub-tasks), load lifting (four sub-tasks), moving along Route (Four subtasks task) and place the load in the desired location (three subtasks). After this step, it's time to identify all the hazards associated with overhead crane work. For this purpose, JSA technology is used.

A review of existing documents, previous studies and interviews with operators of overhead cranes were initially used to identify and analyze the hazards associated with overhead cranes. It should be noted that while the focus of the current study is on identifying hazards associated with overhead cranes, hazards that may be caused by human error or other factors are excluded from the review. In this section, all hazards posed by the equipment itself and threats to the human operator or other persons are identified. The identified hazards associated with overhead cranes using the JSA technique are shown in Tables 1-4.

Table 1-4 the hazards associated with overhead cranes using the JSA technique

code	Identified risks	Duty
H1	Alarms, levers, pedals not working	Inspection before starting work
H2	Wounded current cables and current spread	
H3	Creating load fluctuations due to defects in the electric motor	Lifting the load
H4	Falling of the load due to the inability to bear the weight of the load by the revolving parts	
H5	Chain tearing and load falling due to excessive chain stress, chain decay	Move along the path
H6	Gradual opening and release of the chain from inside the hook due to loose bolts and nuts	
H7	Bending of the wheel or pulley and releasing the crane assembly from inside the rail	
H8	Rusting and breaking the hook and dropping the load	
H9	Breaking the nuts and dropping the load	
H10	The decay of the gears and the hard movement of the gear and the reduction of production efficiency	
H11	Defect in braking and hitting the end pad and the crane coming out of the rail	Place the load in the desired place
H12	Defects in load placement and load fall and damage to equipment or people	

A total of 12 hazards have been identified. After identifying the risks in each phase and based on the risk matrix, their risk numbers are calculated. The risk assessment matrix in the JSA technique is obtained from the product of the probability of an event and the severity of its consequences (Ghaljahi, 2017). For the pre-commencement inspection work, 2 hazards were identified, including non-functioning horns, levers, pedals and damaged power cables and spread of current. 2 hazards have also been identified for load lifting work, which include load fluctuation due to electric motor failure and load falling due to inability of rotating parts to support the weight of the load. The third task was to move along the route, for which the marked hazards included breaking of the chain and falling of the load at the excessive chain tension, chain rot, gradual loosening of the chain from the hook due to loose bolts and wheels. The bending of the wheel and the release of the crane assembly from inside the rail, Rusting and breaking the hook and dropping the load, breaking the nuts and falling of the barrow, rotting the gears and the hard movement of the gears and reducing the production efficiency. The final task is to place the load in the desired location, for which two hazards were identified, including failure to stop and collision with end pads and crane derailment, and failure to place the load and damage to equipment or people .Table 2-4 shows the risk assessment of the identified hazards using the JSA technique.

Table 2-4 the risk assessment of the identified hazards using the JSA technique

Assessment	Risk			Identified risk	Code
	Rank	Intensity	Possibility		
Acceptable with the need for revision	D3	3	D	Alarms, levers, pedals not working	H1
Undesirable	C2	2	C	Wounded current cables and current spread	H2
Undesirable	C2	2	C	Insulation damage and current spread	H3
Undesirable	C3	3	C	Creating load fluctuations due to defects in the electric motor	H4
Acceptable with the need for revision	D3	3	D	Falling of the load due to the inability to bear the weight of the load by the revolving parts	H5
Acceptable with the need for revision	D3	3	D	Chain tearing and load falling due to excessive chain stress, chain decay	H6
Acceptable with the need for revision	D3	3	D	Gradual opening and release of the chain from inside the hook due to loose bolts and nuts	H7
Undesirable	D2	2	D	Bending of the wheel or pulley and releasing the crane assembly from inside the rail	H8
Undesirable	C3	3	C	Rusting and breaking the hook and dropping the load	H9
Acceptable with the need for revision	D3	3	D	Breaking the nuts and dropping the load	H10
Minor	C4	4	D	The decay of the gears and the hard movement of the gear and the reduction of production efficiency	H11
Undesirable	D2	2	D	Defect in braking and hitting the end pad and the crane coming out of the rail	H12

The first step in this section was to determine the criteria and options. The existence of criteria is a necessary option in the implementation of the AHP technique. Criteria are the characteristics of an option. In fact, the criterion is what we choose based on, for example, choosing a manager for the organization, the decision criteria are education, training, personality, etc. The determination of the criteria in this study was carried out on the basis of the work safety analysis method. In this way, the criteria included the severity of the risk, the probability of the risk and the risk assessment. These criteria are a description of opportunities, and opportunities are judged based on these criteria. Opportunities include all identified risks, including 12 risks in this study.

In the next step, a pairing matrix is formed, and the criteria are compared in pairs to evaluate the criteria and prioritize them. In this section, these criteria are compared pair-by-pair and final weights are determined for them.

The parameters were compared two by two and their weights were determined according to each one, then using the software according to the given weights, the general level for each of the parameters was determined. The results showed that the overall risk factor probability was 6 points, the risk intensity factor was 4.5 points, and the aggregate risk rating measure was 1.66 points. Then, in the next step, it was time to calculate the final weight of each parameter. The final weight of each parameter of accident probability, accident severity and risk rating was determined.

The final weight of each criterion was calculated as the sum of the 3 ratings. A comparison of alternatives with the criteria was made. Then the final weight was calculated based on the average weight of each target.

Pairwise comparisons were made such that each risk was compared with other risks based on the criteria and scored. The scores are entered into the software and a weight is determined for each comparison. The final weight of each risk is calculated as the sum of the 12 weights. The results show that, based on the severity criteria, hazard H11, i.e. gear rot and rough gear movement and reduction of production efficiency, had the lowest weight, and hazard H2, i.e. gear injury power cables and current leakage, had the greatest weight. The degree of inconsistency is assessed to determine the consistency of the comparisons made. In fact, the level of inconsistency indicates the degree of confidence in the priorities. If the discrepancy rate is equal to or less than 0.1, it indicates that there is consistency in the pairwise comparison. For pairwise comparisons of the options, the concordance coefficient determined using Expert Choice software was 0.017, indicating good comparison concordance.

Pairwise comparison matrices were constructed for the weight of the criterion relative to the objective and the weight of the alternatives relative to the criterion, and the corresponding calculations are given in Table 11-4.

Table 11-4 the weight of the criterion

Final weight of options			The weight of the criteria relative to the goal		The weight of the options relative to the probability criterion	The weight of the options relative to the intensity criterion	The weight of the options relative to the ranking criteria
H1	۵/۷۶۸				١/٨٩٦٢	٢/٩١٨٥	٢/٨٩٤٣
H2	۶/۴۵۵		۰/۴۷۶		٢/٦٤٦١	٢/١١٩٨	٢/٨٦٨٣
H3	۵/۷۸۶				٢/٠٠٧٣	٢/٩٣٦١	٢/٩٠٥٨
H4	۳/۳۶۱	=		×	١/٠٨٩٩	١/٠٩٥٩	١/١٣٩٥
H5	۱/۲۶۵				٠/٤٢٣١	٠/٤١٧٧	٠/٤٢٣٢
H6	۱/۵۸۷		۰/۷۵۴		٠/٥٤٤٦	٠/٥١٣١	٠/٥٣١٨
H7	۱/۲۹۹				٠/٤٣٣٥	٠/٤٢٩٢	٠/٤٣٥٠
H8	۳/۴۲۱				١/١٢٠٧	١/١٥٩١	١/١٣٨٦
H9	۲/۱۱۰				٠/٦٩٤٥	٠/٦٨٨٠	٠/٧١٢٩
H10	۱/۳۷۲		۱/۷۶۹		٠/٤٥٨٣	٠/٤٥٤٣	٠/٤٥٨٩
H11	۰/۵۴۲				٠/١٧٨٦	٠/١٧٤٦	٠/١٨٤١
H12	۳/۳۵۱				١/١١٧٩	١/١١٤٥	١/١١٨٥

H10	۱/۳۷۲				۰/٤٥٨٣	۰/٤٥٤٣	۰/٤٥٨٩
H11	۰/۵۴۲				۰/۱۷۸٦	۰/۱۷٤٦	۰/۱۸٤۱
H12	۳/۳۵۱				۱/۱۱۷۹	۱/۱۱٤٥	۱/۱۱۸٥

The computations in Table 11-4 were done in such a way that a matrix was prepared using the weighting of the alternative compared to the ranking criteria, likelihood and severity, and multiplied by the weight of the criteria matched to the target, and thus the last weight of the options was calculated.

Table 12-4 Risk rating of overhead cranes

rank	Final weight	Dangers of overhead cranes	Code
۳	۵/۷۶۸	Alarms, levers, pedals not working	H1
۱	۶/۴۵۵	Wounded current cables and current spread	H2
۲	۵/۷۸۶	Insulation damage and current spread	H3
٤	۳/۳۶۱	Creating load fluctuations due to defects in the electric motor	H4
۱۱	۱/۲۶۵	Falling of the load due to the inability to bear the weight of the load by the revolving parts	H5
۸	۱/۵۸۷	Chain tearing and load falling due to excessive chain stress, chain decay	H6
۱۰	۱/۲۹۹	Gradual opening and release of the chain from inside the hook due to loose bolts and nuts	H7
٦	۳/۴۲۱	Bending of the wheel or pulley and releasing the crane assembly from inside the rail	H8
۷	۲/۱۱۰	Rusting and breaking the hook and dropping the load	H9
۹	۱/۳۷۲	Breaking the nuts and dropping the load	H10
۱۲	۰/۵۴۲	The decay of the gears and the hard movement of the gear and the reduction of production efficiency	H11
٥	۳/۳۵۱	Defect in braking and hitting the end pad and the crane coming out of the rail	H12

According to the results in Table 12-4, the top three risks associated with overhead cranes are cable damage and current spread, insulation damage and current spread, alarm, lever, and pedal failure. Also, in the 12th place, gear rot and rough gear movement reduced production efficiency. To determine the consistency of the comparisons made, the inconsistency rate is estimated. In fact, the inconsistency rate shows the level of confidence in the prioritization. If the inconsistency rate is equal to or less than 0.1, it indicates that there is compatibility in the pairwise comparisons. The compatibility rate determined using Expert Choice software for Pairwise comparison of options according to intensity criteria was equal to 0.031, indicating good compatibility of the comparisons.

Mathematical formulas and relationships

The final weight of the options = the weight of the criteria compared to the goal × the weight of the options compared to the criteria

Conclusion

Overhead cranes are the most widely used machines in the industry. The risk assessment of these cranes is done from two perspectives, including human errors and structural and technical perspectives. The present study was conducted with the aim of identifying the occupational hazards associated with overhead cranes with the help of occupational safety analysis method and AHP risk assessment method. The perspective of this study is technical and structural, and the problems related to the crane machine and its equipment are identified and analyzed. The results of this study showed that the JSA technique is an accurate and systematic study method to identify and evaluate the existing or potential risks in each work and process, and in this study, the risks associated with overhead cranes and the combination of AHP technique able to identify the risks associated with overhead cranes and prioritize more effectively. The results show that the damage to the current wiring and the current dispersion, the insulation damage and the current dispersion, and the inability to work the sirens, levers and pedals ranked first to third in the order of risks related to overhead cranes. In addition, the rotten gear and the movement of the hard gear and reduced production efficiency also ranked 12. The general results of this study indicate that the combination of the JSA method with the AHP method can introduce an effective hybrid technique to identifying and prioritizing industrial risks.
Carrying out similar studies to the proposed researches, it is as follows: examining the risks of overhead cranes with other techniques, examining human errors in overhead crane operators and prioritizing identification errors with appropriate techniques, MCDM examining human errors in overhead crane operators and prioritizing identification errors with appropriate techniques MCDM is recommended to investigate human errors in overhead crane operators and prioritize detection errors with appropriate techniques, use techniques with less number of pairwise comparisons such as BWM, conduct research using JSA-AHP technique in other industries.

References

1. Roshan, S.A. and S. Alizadeh, Estimate.(2015).of economic costs of accidents at work in Iran: A case study of occupational accidents in 2012. Iran Occupational Health, 12(1): p. 1-11.
2. Borgheipour, H., et al.(2020). Identification and assessment of human errors among tower crane operators using SHERPA and CREAM techniques. Journal of Health and Safety at Work. 10(1): p. 12-23.

٣. Gholi Pour, M., V. Feyzi, and A. Khammar(2017). Identification and assessment of dangers' risk in production hall of radiator parts a metal industry with JSA method. Occupational Hygiene and Health Promotion Journal. 1(1): p. 42-51.

٤. Jafari, M., et al(2010).The effect of job safety analysis on risk perception of workers at high risk jobs in a refinery. Iran Occupational Health. 6(4): p. 12-25.

٥. Kouhnavard, B., et al(2015). RiskIdentification and Assessment, UsingJob Safety Analysis, in anAffiliated AgencytoIran KhodroCompany, 2014. Beyhagh. 20(3): p. 40-50.

٦. Esposito, P.A., STAR Consultants, Inc. President Annapolis, Maryland.

٧. Ebrahemzadih, M(2016). P296 Application of job safety analysis and william fine methods to identify and control hazards in uranium mine in central area of iran., BMJ Publishing Group Ltd.

٨. Roughton, J. and N. Crutchfield(2011). Job hazard analysis: A guide for voluntary compliance and beyond.: Butterworth-Heinemann.

٩. Yousef, D.A(1998). Satisfaction with job security as a predictor of organizational commitment and job performance in a multicultural environment. International journal of manpower.

١٠. Mohammadi, M., et al(2017). Health Hazards Identification in Institute of Occupation and Technique by Job Safety Analysis in Zahedan.

١١. Ericson, C.A(2015). Hazard analysis techniques for system safety: John Wiley & Sons.

١٢. Schulte, P.A., et al(2005). Integrating occupational safety and health information into vocational and technical education and other workforce preparation programs. American Journal of Public Health, 95(3): p. 404-411.

١٣. HALVANI, G., et al(2016). THE EFFECT OF TRAINING ON RISK ASSESSMENT CODE WITH THE METHOD OF QUANTIFIED JOB SAFETY ANALYSIS IN ONE OF THE UNITS OF ABYEK CEMENT PRODUCTION PLANT.

١٤. Rezaei, M.-S., F. Golbabaei, and M.H. Behzadi(2017). Assessing the healthcare workers' knowledge, attitude, and practice toward health, safety, and environment in an educational hospital affiliated by Iran university of medical sciences (2012-2013). Journal of Environmental Science and Technology. 19(4): p. 347-355.

١٥. Parvin, N., et al(2007). Hazards identification and assessment in a production factory using Job Safety Analysis (JSA). Journal of Environmental Science and Technology. 8(4).

١٦. ghaljahi, m. and s. namrudi(2017). Identification and assessment of hazard risks in a flour mill by the JSA and FMEA methodology. Journal of health research in community. 3(3): p. 82-89.