Risk Analysis in Drill Benches in terms of Occupational Health and Safety

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Abstract

While working on drill benches, there are risks such as ejection of improperly fastened workpieces, breaking of the drill bit, getting the worker's hand, arm, clothes and sheet metal caught in the moving parts. Therefore the aim of this study is to examine drill benches, which are frequently used in the machinery manufacturing industry, in terms of occupational health and safety.Using the "Fine-Kinney Risk Analysis" method, the drill bench used in a medium-sized machinery manufacturing factory in Konya was examined. The visuals taken from the drill benches and the data obtained by live observation were graded in the risk assessment tables.When the data obtained are analyzed; 2 of them are in the "Very High Risk" category, where the work should be interrupted and measures should be taken immediately, 4 in the "High Risk" category which should be eliminated by taking them into the short-term action plan. 2 of them are in the "Significant Risk" category, which should be carefully monitored and eliminated by taking them into the annual action plan, 1 of them are "Absolute Risk" category. Total of 9 risks were identified.With the risk analysis, it was concluded that drill benches contain some risks in terms of occupational health and safety.

Keywords:Occupational health and safety, risk, Fine-Kinney, drilling machines.

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1. Introduction

Today, with industrialization, there is a significant increase in work accidents and occupational diseases in all business lines, both in the world and in our country. Thus, it is crucial to take some measures tomake the work environment of all employees safer and healthier and to protect their physical and mental health. The main purpose of occupational health and safety is to eliminate or minimize the dangers to which the employees are exposed during the execution of the work, and thus to provide protection from losses due to work accidents or occupational diseases or to provide treatment opportunities (Anonymous 2017). The International Labor Organization (ILO) has also summarized occupational health and safety as “providing right people for the right job, the right job for the right person.”

The main purpose of occupational health and safety is to determine the hazards that may harm the health of the employees in the workplace and to take the necessary precautions (Anonymous 2018).It is possible to eliminate or minimize the risks in the working environment. To, it is necessary to protect and improve the physical and mental health of the employees and to protect them from negative effects caused by work and workplace conditions, to have the health problems and occupational diseases detected and treated in a timely manner, to enable employees who have been harmed by being exposed to work accidents or occupational diseases to work in jobs that are more suitable for them, to determine the severity and effects of the damages with objective and scientific methods, to provide the necessary inferences, to eliminate both material and moral damages (Anonymous 2017).

As technology develops and production volumes increase, it is very important to conduct risk analyzes to prevent accidents and stop the production line. Occupational Health and Safety Law No. 6331 emphasizes the necessity of taking precautions against the risks they may cause by revealing hazards.As stated in the Occupational Health and Safety Law, the employer is obliged to make a risk assessment in terms of occupational health and safety (Anonymous 2012). Since the dangers and risks awaiting the employees are not known in the enterprises without risk assessment, the environment is prepared in those places for the occurrence of work accidents and occupational diseases (Akpınar andÇakmakkaya, 2014).Risk assessment is a process that starts with an analysis of the current situation in an enterprise and results in the taking and monitoring of control measures in order to eliminate or adequately reduce all risk factors for the health and safety of employees in the working environment. Risk assessment studies are a process that should be constantly reviewed and necessary updates should be made as a result of changes that may occur in the business system. The risk assessment process is summarized in Figure 1 in its most general form (Aker 2019).

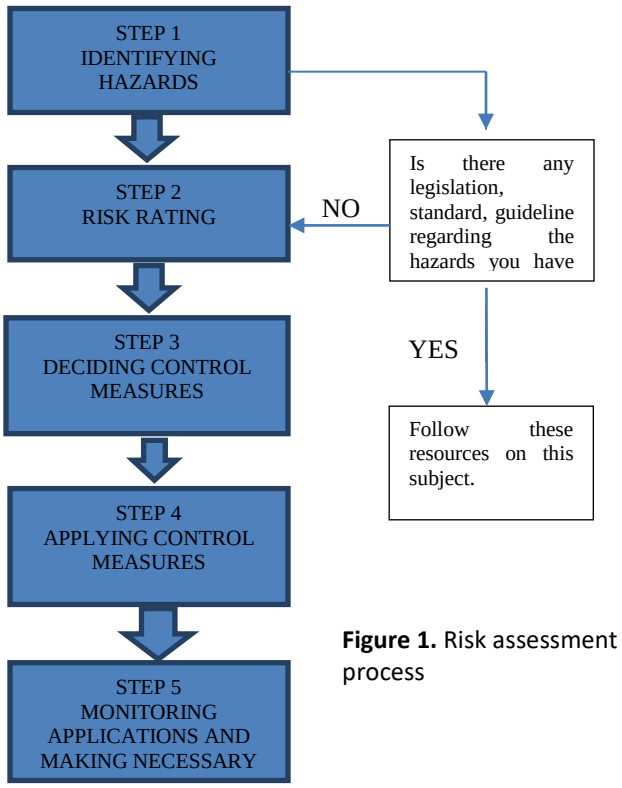

Figure 1. Risk assessment process

Occupational Health and Safety Risk Assessment Regulation, which covers all workplaces related to risk assessment, which is one of the most important responsibilities of the employer, entered into force after being published in the Official Gazette dated 29.12.2012 and numbered 28512 (Anonymous 2012).

Machinery manufacturing industry is one of the most risky sectors in terms of working conditions both in our country and in the world. Machinery operators are exposed to high noise in enterprises that have a large number of machine tools in the machinery manufacturing industry. In this process, it is necessary to reduce the sound level (Albayrak et al. 2020). In terms of work accidents that have occurred in our country in recent years, the metal sector, which has important risks such as dust, noise, temperature, rays and radiation, is in the first place (Anonymous 2018). Therefore, threats in the manufacturing industry should be classified and risk analysis should be done.

Before starting the risk assessment studies, it is necessary to reveal the current situation of the business system to be evaluated in all aspects and to conduct a good legislative research. In this step, which is defined as preliminary preparation, a correct understanding of the current state of the business system with all its elements is a critical step in identifying hazards and risks. The accuracy and effectiveness of risk assessment studies largely depend on the accuracy of this step (Anonymous 2017). During the evaluation phase, the definition of hazards and risks should be made correctly and these hazards should be associated with correct data. There are approximately 150 risk assessment methods, including qualitative, quantitative and mixed. However, although not every method is actively used, it is not appropriate to use the same method in every sector (Eker and Özçelik2020).

In this study, risk assessment was carried out using the Fine-Kinney method on a drill bench, which is generally used in a mid-tier machinery manufacturing factory in Konya, in accordance with risk assessment methods, where operations such as drilling, reaming, hole enlargement, countersinking and tapping are performed.

2. Material and Method

2.1. Research Design

This study was carried out using the "Cross-sectional Research" method. Cross-sectional studies are studies that examine the cause-effect relationship at a single point in time (Çaparlar and Dönmez2016).

2.2. Research Place

The research was conducted in a mid-tier machinery manufacturing factory in Konya.

Figure 2. Working on drill benches

2.3. Analysis of Data

Fine-Kinney method has been applied in risk assessment for all activities on the drill bench. The Fine-Kinney method is a qualitative risk assessment method and was first developed for the "California Naval Weapons Station" in 1971. It was later updated by Kinney G.F. and Wiruth A.D. in 1976 and used under the name of “mathematical evaluation for controlling hazards” (Fine 1971; Kinney and Wiruth1971).

In this method, unlike other risk assessment methods, the frequency scale is also taken into account. While applying the method, 3 risk scales are used, namely Probability (P), Frequency (F) and Severity (S), and the values of the event are found from the relevant charts and these values are multiplied mathematically, thus the risk score is calculated. Namely; *Risk Score (R) = Probability (P) x Frequency (F) x Severity (S)* (Özdemir 2021). According to this;

- Possibility: The probability of the damage occurring over time
- Frequency: Frequency of exposure to danger
- Severity: Indicates the degree of results.

The Fine-Kinney method is very practical, simple, convenient in ordering risks and advantageous in helping decision makers determine their priorities. In the charts below, the probability, frequency and severity values of the Fine-Kinney method, the meanings of these values and the risk assessment results obtained by multiplying these values are given (Erzurumluoğlu et al. 2016).

Table 1. Probability scale of Fine-Kinney risk assessment

Probability Value	Meaning
0.2	Practically impossible
0.5	Conceivable but very unlikely
1	Only remotely possible
3	Unusual but possible
6	Quite possible
10	Might well be expected

Table 2. Frequency scale of Fine-Kinney risk assessment

Frequency Value	Meaning
0.5	Very Rare (Yearly)
1	Rare (a few per year)
2	Unusual (monthly)
3	Occasional (weekly)
6	Frequent (daily)
10	Continuous (Continuous or more than once per hour)

Table 3. Severity scale of Fine-Kinney risk assessment

Violence	Meaning
1	Noticeable (Mild, Harmless
3	Important (Minor Job Loss,
7	Serious (Significant
15	Very Serious (Injury, Limb
40	Disaster (Death, Complete
100	Catastrophic (Multiple

Table 4. Consequence scale of Fine-Kinney risk assessment

Risk Value	Risk Assessment Consequence
R <20	Risk; perhaps acceptable (May Not Require Urgent Action)
20 <R <70	Possible Risk; attention indicated (Must Be Included in the Action Plan)
70 <R <200	Substantial Risk; correction needed (Must Be Considered, Included in Annual Action Plan)
200 <R <400	High Risk; immediate correction required (Should be Included in the Short-Term Action Plan)
R> 400	Very High Risk; consider discontinuing (Immediate Action Should Be Taken by Suspending the Study)

3. Findings and Discussion

Table 5. Risks in the "very high risk" category in drill benches and measures to reduce/eliminate the risk

SECTION	DANGER	SOURCE OF DANGER	IDENTIFIED RISK	RISK RATING				CORRECTIVE PREVENTIVE ACTIONS TO BE/SHOULD BE DONE
				POSSIBILITY	FREQUENCY	SEVERITY	RISK SCORE	
Drill Bench	Manual intervention in the operation area while the machine is working. Drill machine catches hand/arm	Drill bench and moving parts	Injury, Loss of limb	6	6	15	540	1. Immediate Action Should Be Taken by Suspending the Work 2. Protection systems should be made to prevent intervention in the operation area while the machine is working. 3. Awareness level should be increased by giving necessary trainings to the employees.
Drill Bench	Not choosing the appropriate bit for the material to be processed, Flying of the workpiece, breaking the bit	Drill bench and moving parts	Noise, accident, injury	6	6	15	540	1. Immediate Action Should Be Taken by Suspending the Work 2. The bit appropriate for the material to be worked on should be selected. 3. Awareness level should be increased by giving necessary trainings to the employees.

When Table 5 is examined, it is seen that the drill benches are in the very high risk category due to the dangers such as manual intervention in the operation area while the machine is working, getting caught in the operation area, not selecting the bit appropriate for the material to be processed, flying of the the workpiece and breaking the bit.

Table 6. Risks in the "High Risk" Category in Drilling Machines and Measures to Minimalize/Eliminate the Risk

SECTION	DANGER	SOURCE OF DANGER	IDENTIFIED RISK	RISK RATING				CORRECTIVE PREVENTIVE ACTIONS TO BE/SHOULD BE DONE
				POSSIBILITY	FREQUENCY	SEVERITY	RISK SCORE	
Drill Bench	Employment of those who do not have vocational education and qualification certificates	Personnel working at the drill bench	Accident injury	6	3	15	270	1. It should be resolved by taking it into the Short-Term Action Plan. 2. Employees should be given vocational training courses, certificates of competence should be obtained, and awareness levels should be increased.
Drill Bench	Working with a dull drill bit, flying of the broken drill bit	Drill bench and moving parts	Accident injury	6	6	7	252	1. It should be resolved by taking it into the Short-Term Action Plan. 2. Drill bits should be checked periodically and dulled bits should be replaced with new ones.
Drill Bench	Belt and pulley system on the bench is open, hand, arm or clothes are caught	Drill bench and moving parts	Accident injury Loss of Limb	3	2	40	240	1. It should be resolved by taking it into the Short-Term Action Plan. 2. The belt pulley system must be in a protected chamber and must be closed at all times. 3. The chamber should be closed again after maintenance or speed adjustment operations.
Drill Bench	Flying of small pieces or burr	Drill bench and moving parts	Accident injury	6	6	7	252	1. It should be resolved by being included in the Short-Term Action Plan 2. Necessary personal protective equipment should be used while working on the bench. 3. The awareness level of the employee should be increased by providing the necessary trainings.

When Table 6 is examined, it can be seen that drill benches are in the high risk category due to dangers such as operating the drill benches withoutvocational education and qualification certificates, working with dull drill bits, flying off the broken drill

bit, open belt and pulley system on the machine, getting caught of the hand, arm or clothes, flying of small pieces or burrs.

Table 7. Risks in the "Significant Risk" Category in Drilling Machines and Measures to Minimalize/Eliminate the Risk

SECTION	DANGER	SOURCE OF DANGER	IDENTIFIED RISK	RISK RATING				CORRECTIVE PREVENTIVE ACTIONS TO BE/SHOULD BE DONE
				POSSIBILITY	FREQUENCY	SEVERITY	RISK SCORE	
Drill Bench	Working without firmly clamping the workpiece to the table or bench vise, Flying of the piece	Drill bench and moving parts	Accident Injury, Death	3	3	15	135	1. It should be carefully monitored and remedied by being included in the Annual Action Plan. 2. It should be ensured that the workpiece is firmly attached to the table or bench vise. 3. The level of awareness should be increased by giving the necessary training to the personnel.
Drill Bench	Failure to check machine cables and grounding measurements, Electric shock	Drill bench and moving parts	Accident Injury, Death	3	1	40	120	1. It should be carefully monitored and remedied by being included in the Annual Action Plan. 2. Electrical cables of work equipment should be checked before working. 3. Grounding measurements should be made and the awareness level of the employees should be increased.

When Table 7 is examined, it is seen that drill benches are in the important risk category due to dangers such as working without firmly connecting the workpiece to the table or bench vise, flying of the part, not checking the workbench cables and not making grounding measurements, electric shock.

Table 8. Risks in the "Absolute Risk" Category in Drilling Machines and Measures to Minimalize/Eliminate the Risk

SECTION	DANGER	SOURCE OF DANGER	IDENTIFIED RISK	RISK RATING				CORRECTIVE PREVENTIVE ACTIONS TO BE/SHOULD BE DONE
				POSSIBILITY	FREQUENCY	SEVERITY	RISK SCORE	
Drill Bench	Not using suitable work clothes, Getting the work clothes caught in the moving part of the workbench	Drill bench and moving parts	Accident injury	3	1	15	45	1. It should be included in the Action Plan 2. Loose clothes should not be worn, the sleeves of the work clothes should be elastic and the buttons should be fasten.

When Table 8 is examined, it is seen that it is in the absolute risk category due to the danger of not using suitable work clothes while working on drill benches and getting the work clothes caught in the moving part of the workbench.

4. Results

Drilling machines are frequently used in today's industry. These machines are mostly used mounted on a work table or fixed to the floor and perform the function of creating non-precision holes.

The radial type (universal) drill benches, which are the subject of this study, have the ability to move 360 degrees around their axis. These console-mounted workbenches are used for drilling and countersinking large workpieces. Radial drill benches consist of a lower table, column, console that can make radial movement on the column, and a drilling head that moves back and forth on the console. These machines can drill holes up to 50 mm in diameter (Anonymous 2012)

The purpose of the studies to ensure Occupational Health and Safety is to create a healthy work environment by protecting all employees from occupational accidents and diseases. Providing occupational health and safety in any facility ensures that the people who benefit from this facility and other individuals in the community are indirectly protected from the risks, and creates awareness about safety in the community. It is very important to make a risk assessment in order to provide a healthy work environment. In this context, a risk assessment has been planned to prevent accidents that may occur while working on drill benches, which are frequently used in machine shops.

In this study, which was carried out using the Fine-Kinney risk assessment method, a total of 9 risks were identified, including 2 in the Very High Risk, 4 in the High Risk, 2 in the Significant Risk and 1 in the Absolute Risk categories, and the measures to be taken against these risks were identified.

When Table 5 is examined, it is seen that the drill benches are in the very high risk category due to

the dangers such as manual intervention in the operation area while the machine is working, getting caught in the operation area, not selecting the bit appropriate for the material to be processed, flying of the the workpiece and breaking the bit.

It is known that most of the accidents are caused by careless behavior and inexperience. It has been determined that it is in the high risk category due to dangers such as employing those who do not have vocational education and qualification certificates, working with dull drill bits, flying of the broken drill bit, opening the belt and pulley system on the bench, getting caught the hand, arm or clothes, flying of small pieces or burrs (Table 6).

It has been revealed that it is in the significant risk category due to dangers such as working without clamping the workpiece tightly to the table or bench vise, flying of the part and not checking the machine cables and grounding measurements, electric shock (Table 7).

It has been found that it is in the definite risk category due to the danger of not using suitable work clothes and getting the work clothes caught in the moving part of the workbench (Table 8).

In the risk assessment application, the rating charts related to the hazards identified in the drill bench and the risks it may cause are given in the application annexes, the results obtained and the measures to be taken for the risks are given in the continuation of the tables. Accordingly, the rules to be followed in general are as follows;

- The workpiece to be drilled or countersinked must be firmly clamped to the bench vise to prevent it from swinging.
- The drill chuck key should not be left on it.
- While working, the body, especially the head, should be kept at a safe distance from the bench.
- The features of the machine used should be well known.
- Coolant liquid should be used both to ensure work efficiency and quality and to extend the life of the drill.
- Never work with a dull drill bit.
- The sleeves of the work clothes should be elastic so that they are not tangled in the drill.
- The working area should always be kept clean, and materials such as oakum should not be touched by the drill bit while drilling.
- Wood or metal chips formed on the table should not be cleaned by hand or by blowing, brushes should be used for cleaning.
- Since the drill shaft continues to turn for a certain time after the drill is turned off, the drill shaft should never be grasped by hand before the drill comes to a complete stop.

It is thought that the suggestions given to minimize/eliminate the risks in the findings charts should be taken into action quickly and such researches are not given much place especially in the field of machinery manufacturing industry, and it is recommended to conduct researches on different workshops in this regard.

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