



## ASSESSMENT OF THE PROBLEMS FACED BY CONSTRUCTION EQUIPMENT OPERATORS ACTIVELY WORKING IN THE FIELD AND RISK ANALYSIS OF ACTIVELY USED EQUIPMENT

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### Abstract

Original scientific paper

When research and statistics on operators actively working in the field are carefully examined, it becomes clear how serious the consequences of accidents caused by construction machinery can be. Workplace accidents caused by construction machinery and the issues they encounter rank among the top categories of accidents resulting in death or the loss of the ability to continue working when compared to other workplace accidents in the industry. To minimize workplace accidents and issues that may arise due to operator negligence when using machinery actively on the job site, certain precautions must be taken. To minimize these situations, the following measures are listed: timely maintenance of machinery, increasing the rest periods for both the machinery and the operator, increasing training and practical exercises, conducting a site survey before work begins, and implementing workplace safety measures. In our study, research and technical analyses were conducted on the problems encountered by operators actively working in the field in order to enable them to work more efficiently. Additionally, risk analyses of construction machinery actively used in the field were conducted, and the results were examined. Six types of construction machinery were included in the risk analysis conducted in our study. For forklifts, the importance level was 1 and the risk value was 20, with the highest risk activity identified as hazards arising from trucks, trailers, and workers entering the forklift work area. As a result of our study, the importance of operator training, the organization of the work site, the importance of periodic maintenance of construction equipment, and the importance of controlling the effects of work-related stress have been highlighted.

**Keywords:** Construction machinery, operator, occupational health and safety, occupational accident factors, risk analysis.

## SAHADA AKTİF OLARAK ÇALIŞAN İŞ MAKİNELERİ OPERATÖRLERİNİN KARŞILAŞTIKLARI SORUNLARIN DEĞERLENDİRİLMESİ VE AKTİF OLARAK KULLANILAN EKİPMANLARIN RİSK ANALİZİ

### Özet

Orijinal bilimsel makale

Sektörde sahada aktif çalışan operatörlere yönelik araştırmalar ve istatistikler dikkatli bir şekilde incelendiğinde, iş makineleri kaynaklı kazaların ne denli ciddi sonuçlara yol açmış olduğu görülmektedir. İş makineleri kaynaklı iş kazaları ve karşılaştıkları sorunlar, neticeleri itibarı ile sektördeki öteki iş kazaları ile karşılaştırıldığında ölümlü veya devamlı iş yapabilme kabiliyetini kaybetme ile sonuçlanan kaza çeşitleri arasında üst sıralarda yer almaktadır. İş sahasında aktif bir şekilde kullanılan makinelerin operatörlerin dikkatsizliği sonucu doğabilecek iş kazaları ve karşılaşılabileceği sorunları minimum düzeye indirebilmek için birtakım tedbirler almak zarureti ortaya çıkmıştır. Bu durumu minimuma indirmek için; makine bakımlarının zamanında yapılması, makinenin ve operatörün dinlenme zamanlarının artırılması, eğitimlerin ve uygulamaların çoğaltılması, çalışma öncesi zemin etüdünün yapılması ve çalışma sahasındaki iş güvenliği tedbirlerinin alınması olarak sıralanmaktadır. Çalışmamızda başlıca etken olarak sahada aktif çalışan operatörlerin daha verimli çalışabilmesi için karşılaştıkları sorunlara yönelik araştırmalar ve teknik incelemeler yapılmıştır. Ek olarak sahada aktif olarak kullanılan iş makinelerinin risk analizleri yapılmış ve sonuçları incelenmiştir. Çalışmamızda yapılan risk analizinde 6 tane iş makinesine yer verilmiştir. Bu iş makinelerinden forkliftler için önem derecesinin 1 olduğu ve risk değerinin 20 olduğu değerler ile en yüksek olan aktivite forklift çalışma alanına kamyon, tır ve çalışanların girmesinden kaynaklı tehlikeler olarak görülmektedir. Çalışmamızın sonucu olarak operatör eğitimlerinin önemi, çalışma sahasının düzeni, iş makinasının periyodik bakımlarının önemi ve iş stresi etkisinin kontrolünün önemi ortaya çıkmıştır.

**Anahtar Kelimeler:** İş makineleri, operatör, iş sağlığı ve güvenliği, iş kazası etkenleri, risk Analizi.

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Received 01 January 2025; Received in revised form 16 March 2025; Accepted 07 April 2025

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Doi: <https://doi.org/10.46460/ijiea.1611365>

## 1 Introduction

Construction machinery, which is one of the biggest requirements of our age, is of great importance in working areas within the developing heavy industry. Developments in construction machinery lead to an increase in studies in the energy sector. In this context, there are alternative fuel production studies that can meet the needs of construction equipment [1-3]. With advancing technology, it is seen that the accidents that operators using construction machinery are exposed to can be reduced and largely prevented by the importance of operator training and the organization of the work site. In terms of the number of occupational accidents and their severe consequences, accidents on construction machinery are in the first place worldwide [4]. In order to minimize the negativities that occur in construction machinery, work organization is of great importance in terms of the risks that will arise during the work and the measures to be taken. Today, occupational health and safety comes to the forefront in all sectors [5]. The material losses of occupational accidents show that many studies in Europe have reached a grave economic loss dimension [6]. In our country, unlike industrialized countries, there is no decrease in the rate of occupational accidents, but fluctuations from year to year are noteworthy. This is an indication that the necessary precautions are not taken and the lack of education is at the highest level [7]. If the causes of accidents caused by construction machinery are examined, it is seen that approximately 50% of the accidents are caused by the faulty behaviors of the operators and working in the work site without taking the necessary precautions [8]. It is seen as a result of researches that the main cause of accidents is errors caused by lack of training [9]. Due to the unfavorable conditions of the working environment of construction machinery maintenance and repair, accident and injury risks that require occupational health and safety measures may arise. In cases where risks cannot be completely eliminated, it is important to use personal protective equipment suitable for maintenance [10]. As a result of literature reviews and researches on construction machinery, it is possible to summarize the main measures to be taken in order to prevent possible occupational accidents under three main headings as operator training, taking necessary occupational safety measures in the work area, and performing periodic maintenance and repair of construction machinery on time [11]. Reducing and controlling risks is the most important part of an effective occupational health and safety work [12]. Based on these literature researches, in order to eliminate the deficiency in the literature and to contribute, researches and technical examinations were carried out on the problems faced by the operators working actively in the field in order to work more efficiently as the main factor in our study. As a contribution to the literature, our study contributed to the literature in terms of addressing the problems of construction equipment operators working actively in the field and statistically evaluating all the problems

experienced not only in terms of occupational safety. In addition to our study, risk analyzes of the construction machinery actively used in the field were made and the results were examined. When the results of our study are examined, it is seen that the most work accidents are experienced in loaders, the reason for this is that the daily working hours are more than 8 hours and the break times are not sufficient. Lack of certification and training of operators, irregularities in the working area, lack of periodic maintenance and scrapping of work machines were seen as the main causes of occupational accidents. When the types of accidents were analyzed, it was determined that 17.4% of the accidents occurred as a result of material fall. Problems arising from inadequate performance of work machines were evaluated at a rate of 16.5%. Failure to comply with occupational safety rules accounted for 13% of the accidents. Problems caused by encountering irregular working area in the work site were determined at a rate of 18.7%. Problems arising from overheating and overloading of work machines were identified at a rate of 13%. Finally, problems caused by work pressure and stress in the workplace were determined as 21.4%. When we look at the occupational safety and health statistics that emerged as a result of research on working with construction machinery in our country, it shows improvement compared to previous years. Our study contributed to the literature by addressing the problems of construction equipment operators actively working in the field and statistically evaluating all the problems experienced not only in terms of occupational safety. As a result of our study, the importance of operator training, the organization of the work area, the importance of periodic maintenance of the work machine and the importance of controlling the effect of work stress have emerged. In the risk analysis study, the highest activity for forklifts with a severity level of 1 and a risk value of 20 is seen as the hazards caused by trucks, trucks and employees entering the forklift work area. For cranes, the highest activity with a severity level of 1 and a risk value of 15 is seen as the hazards arising from the crane getting off the rails and going off the road in the crane gantry walk from the activities of crane use in stacking. For Container Stacking (Rtg Spreader), the activity with a rating of 1 and a risk value of 16, the highest activity is hazards from the rollers in the Mayna lifting system. For Handling Work Machine, the activity with a rating of 1 and a risk value of 15, the highest activity is the hazards caused by the employees entering under the load lifted by the machine. For Stacker Work Machine, the highest activity with a degree of 1 and a risk value of 20 is seen as the dangers arising from the fast maneuvering of the stacker operators with the work machine in the field and exceeding the specified speed limit. For Tractor Work Machine, the activity with a degree of 1 and a risk value of 16, the highest activity is seen as hazards caused by limbs hitting the moving rotating parts of the tractor in operation, getting stuck, etc. A schematic view of our study is given in Figure 1.



Figure 1. Schematic view showing our study.

## 2 Statistical Data

Many people lose their lives or become incapacitated due to the problems experienced by operators. In this study, a research was conducted on those working as active operators in the field and statistical data were analyzed. The variety of construction machines actively used in the fields and the proportions of these machines with the highest accident risk are given in Figure 2.

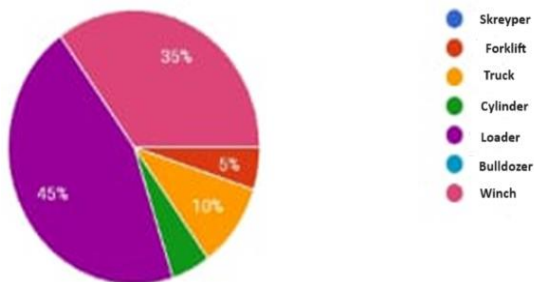


Figure 2. Ratios of the most accident-prone construction equipment active in the field.

There are machines available for different jobs used in different projects. The distribution of construction machinery accidents according to project types is shown in Figure 3 below.

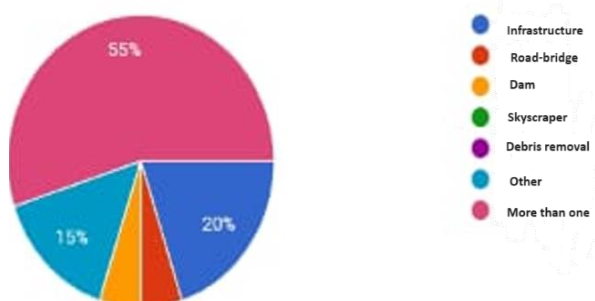


Figure 3. Distribution of construction equipment accidents according to project types.

Experience is an important factor in reducing work accidents. Apart from the experience in the use of construction machinery, knowing the machine is as important as using it. Below, the experience of the operators on the basis of years is given statistically in Figure 4[10].

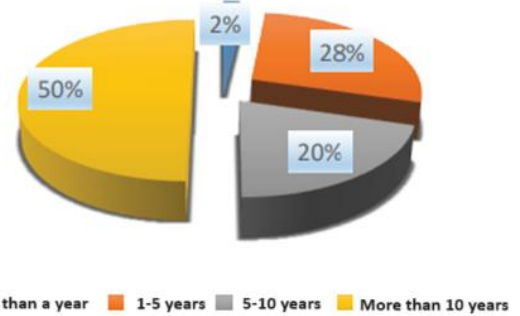


Figure 4. Years of experience of construction equipment operators.

The starting times and breaks of the operators at the work site are important parameters for the healthy execution of the work. Figure 5, Figure 6 and Figure 7 below show the starting times of the operators, the duration of their daily work, and the number of breaks they take at intervals of hours, respectively.

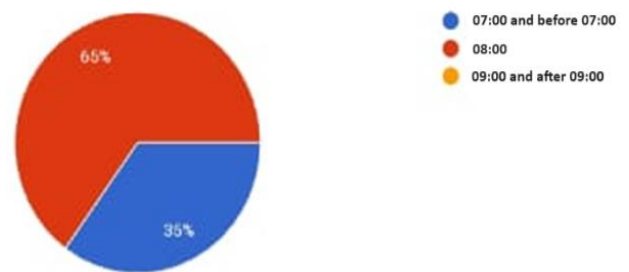


Figure 5. Starting times of construction equipment operators.

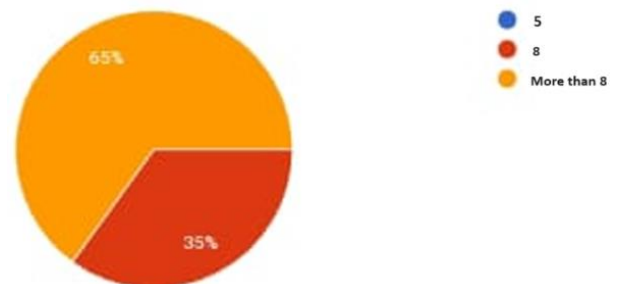


Figure 6. Daily working hours of construction equipment operators.

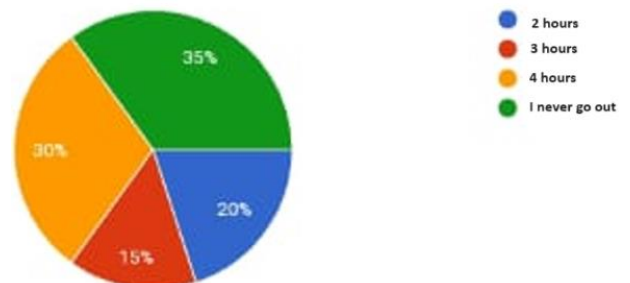


Figure 7. How many hours apart the construction equipment operators take breaks.

In line with these examinations, it is concluded that the operators do not allocate much time for rest, their daily working hours are long and working in this direction increases the possibility of accidents.

The educational status of the operators using construction machinery, their occupational health and

safety training, whether they have occupational safety certificates and driver's licenses, and from whom they received their operator training, the issues that may be effective in the formation of occupational accidents are examined in figures 8, 9, 10 and 11.

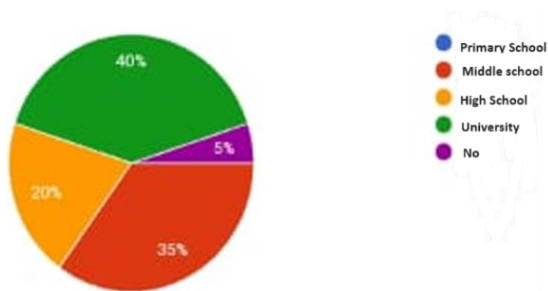


Figure 8. Education level of construction equipment operators.

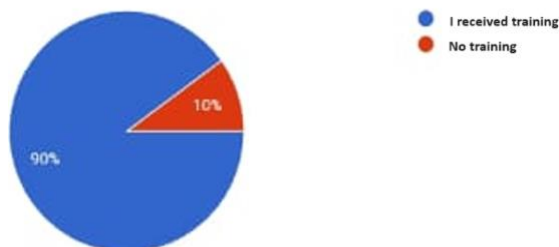


Figure 9. Occupational health and safety trainings received by construction equipment operators.

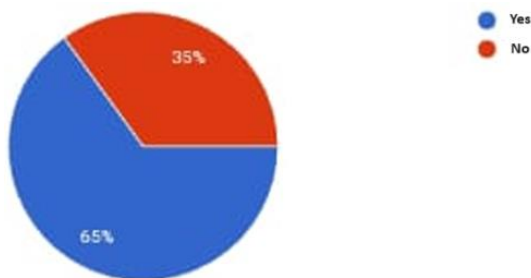


Figure 10. Whether construction equipment operators have occupational safety certificates and driving licenses.

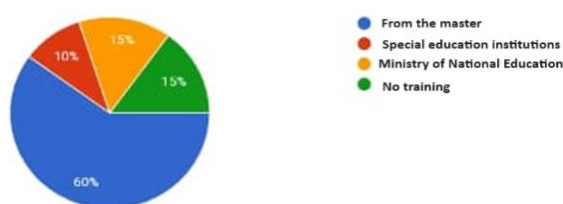


Figure 11. From whom the construction equipment operators received their operator training.

In line with these examinations, it is seen that it is important to have an operator's license. Thanks to the authorized institutions, this number is increasing day by day. It is important that the document that people using construction machinery must have belongs to the relevant machine model. It is wrong for an operator with a Backhoe-Loader work machine license to use another machine on the construction site. Each construction machine requires a different driver's license. The training received through the courses provided by authorized institutions ensures that machines of different models are used by people who have received training on that model. A driver's license is only a document related to machine

use. Apart from this, it is important that each operator receives training on the use of the machine, its maintenance and OHS rules that must be followed during use. When the types of accidents that occur in construction machinery are examined, the most common accidents were tried to be determined. The aim here is to determine the most common types of accidents and to further increase the precautions. The leading accident types are given in Figure 12.

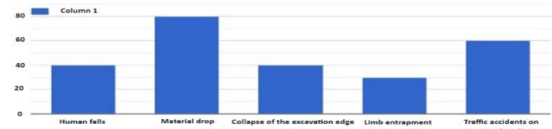


Figure 12. Types of accidents on construction equipment.

When the problems arising from the insufficient performance of the construction machinery were evaluated as 1 being the least and 5 being the most, the responses were analyzed. The statistical percentages are given in Figure 13.

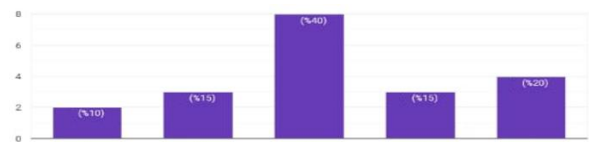


Figure 13. Problems caused by inadequate performance of construction equipment.

The responses of the operators to the problems that occur in case of non-compliance with occupational safety rules were analyzed when 1 is the least and 5 is the most. The statistical percentages are given in Figure 14.

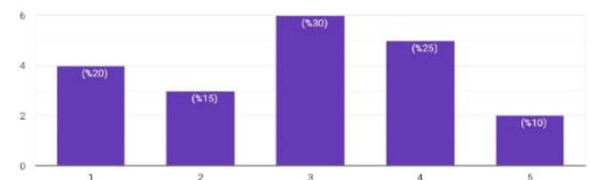


Figure 14. Accidents that occur when occupational safety rules are not followed.

Problems related to the work area, which operators encounter irregularly, without ground surveys, without taking the necessary precautions in the work areas, were examined. The measures to be taken against these problems were considered among the most important issues to protect worker health. When the problems occurring in case of encountering an irregular working area at the work site were evaluated as 1 being the least and 5 being the most, the answers encountered were examined. The statistical percentages are given in Figure 15.

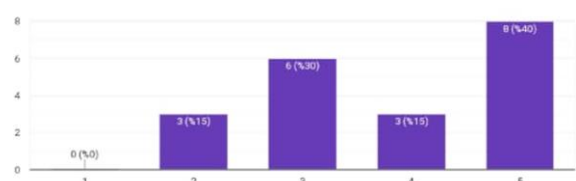


Figure 15. Encounters with irregular workspace at the worksite.



Problems related to work pressure and stress have been examined by their employers in the workplaces of the operators. The measures to be taken against these problems are important for the worker to carry out the work in a healthy way and to make healthy decisions. When the problems occurring in case of encountering work pressure and stress in the workplace were evaluated as 1 being the least and 5 being the most, the answers encountered were examined. The statistical percentages are given in Figure 16.

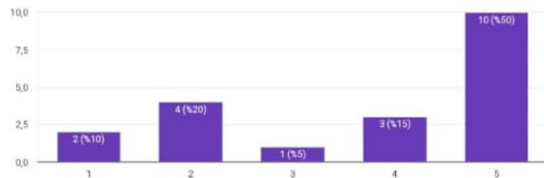


Figure 16. Work pressure and stress in the workplace

Occupational accidents caused by mechanical failures that may occur due to overheating and overloading of construction machinery are among the other important issues examined. When the problems occurring in case of overheating and overloading of construction machinery were evaluated as 1 being the least and 5 being the most, the responses were analyzed. The statistical percentages are given in Figure 17.

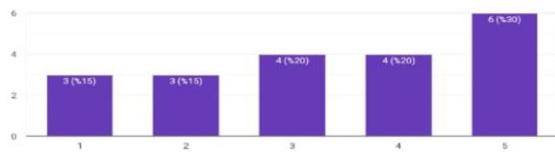


Figure 17. Overheating and overloading of construction equipment.

### 3 Risk Analysis

One of the most important causes of occupational accidents is the lack or incomplete risk analysis in critical areas. Risk assessment is defined as “the necessary studies to be carried out in order to identify the hazards that exist in the workplace or that may come from outside, to analyze and grade the factors that cause these hazards to turn into risks and the risks arising from hazards and to decide on control measures”. With Risk Analysis Studies on Construction Machinery, serious consequences such as injury, loss of limbs, damage to the heart and respiratory systems and death can be prevented. In this respect, risk analysis of 6 construction machines was carried out in our study. In the risk analysis method applied as an example to the study to determine the risks, the matrix method was selected. The reason for choosing this method is that the results of possible risks can be graded. In the event of the realization of the hazard, the severity of the harm or damage that this hazard will cause to people, workplace and environment can be evaluated. According to the magnitude of the risk value, i.e. the height, the urgency of the measures to be taken and what can be done as a precaution is determined and the risk analysis study is completed.

#### 3.1 Risk Analysis Study on Forklifts

In the risk analysis study, the highest activity for forklifts with an importance level of 1 and a risk value of 20 is seen as the hazards caused by trucks, trucks and employees entering the forklift work area. Risk analysis study on forklifts is given in Table 1.

Table 1. Risk analysis study on forklifts.

Activity	Danger	Root Cause of Danger	Risks Arising from Hazard	Impacts	Exposed Persons	Probability	Violence	Risk	Degree of Importance
Loading and unloading	Trucks, trucks and employees entering the forklift work area	Uncontrolled entry of employees and vehicles into the forklift work area	Risk of collision of forklifts and vehicles, risk of crushing workers	Material damage accident, loss of life, injury	Truck and lorry drivers, container yard workers	4	5	20	1
Maintenance, repair and control works	Diesel engine electrical connections	Starting work without taking the necessary safety precautions	Risk of electric shock	Injury	Forklift machine operators, electricians, engine mechanics	2	4	8	2
Maintenance, repair and control works	Moving rotating parts of a diesel generator in operation	Movable rotating parts	Risk of injury or entrapment of limbs due to contact of body parts	Injury	Engine mechanics, electricians	3	3	9	2
Maintenance, repair and control works	Electrical circuits on the forklift work machine	Exposure to electric current	Risk of electric shock	Injury	Electricity masters	2	4	8	2
Maintenance, repair and control works	Pin removal operations on machine connection points	Throwing of parts on the machine	Damage to employees due to swinging and dislocation of apparatus	Injury	Workshop masters, engine mechanics	3	3	9	2
Tire change	Tire changes on machines	High air pressure inside the tire, components that allow the tires to be fixed	Risk of crushing the worker during tire removal	Injury	Engine mechanics, external service	4	3	12	2
Loading and unloading	Risk of falling load carried by forklift crushing the worker	Failure to load the load safely onto the work machine	Falling of the transported or suspended load, crushing the employee as a result of its movement, overturning of the forklift	Loss of life, injury	Forklift operator, chock and pointer worker	3	5	15	1

### 3.2 Risk Analysis Study on Cranes

a risk value of 15 is the use of cranes in stacking activities.  
Risk analysis study on Cranes is given in Table 2

For Cranes, the highest activity with a rating of 1 and

**Table 2.** Risk analysis study on Cranes.

Activity	Danger	Root Cause of Danger	Risks Arising from Hazard	Impacts	Exposed Persons	Probability	Violence	Risk	Degree of Importance
Stacking	Rope and rope pulleys	Failure to check the ropes, entry of employees or drivers into the crane working area	Risk of rope breakage, risk of damage to the ropes by falling parts as a result of rope pulleys breaking	Loss of life, injury, material damage	Porch workers, truck drivers who load and unload cargo at the porch	2	5	10	2
Stacking	Control and maintenance work to be carried out at the crane top	Starting work without taking safety precautions	Risk of falling from height	Loss of life, injury	Engine mechanics, electricians and external service personnel performing periodic checks	3	5	15	1
Stacking Crane Usage	Crane derails during gantry walk and goes off the road	Deformation of the crane rails, disintegration of the bearing inside the crane wheels, fast movement of the crane when loaded	Risk of braking failure due to crane inertia, risk of damage to vehicles and cargo, risk of crushing workers	Accident with loss of life, injury and property damage	Crane operators, truck drivers and shed workers	3	5	15	1
Stacking Crane Usage	Using the crane at an inappropriate speed	Failure of the crane operator to comply with the specified written instructions	Risk of the crane going off the road and harming people working around it, risk of damage to crane mechanical parts	Accident with loss of life, injury and property damage	Crane operators, truck drivers and shed workers	2	5	8	2
Stacking Crane Usage	Stairs to reach the load lifting crane platform	Contamination of stairs with dust and slippery materials, damaged stair guards and steps	Fall risk	Injury	Engine mechanics, electricians and external service personnel carrying out the inspection process	3	3	9	2
Stacking Crane Usage	Using the crane above its carrying capacity, lifting loads exceeding the maximum carrying capacity	Failure of the operator to comply with the specified crane operating instructions	Risk of damage to lifting equipment such as ropes, hooks, etc. as a result of damage to the load and damage to the surrounding area	Loss of life, injury, property damage accident	Crane operators, truck drivers and shed workers	3	5	15	1
Stacking Crane Usage	Planned maintenance and malfunctions not being eliminated on time	Inappropriate planned and breakdown maintenance	Risk of serious accidents due to improper operation of the system as a result of improper maintenance	Accidents involving loss of life, injury, property damage	Crane operators, truck drivers, truck drivers and shed workers	2	5	10	2
Using Cranes for Stacking	Leaving loads on the crane walkway, parking vehicles	Failure to comply with the specified stacking plan, failure to comply with the specified safety rules by vehicle drivers and failure to supervise this situation by employees	Risk of crane derailment due to collision and damage to the surrounding area	Accidents involving loss of life, injury, property damage	Crane operators, truck drivers, truck drivers and shed workers	2	5	10	2
Loading crane use in stacking	Crane monorail mechanism and other construction, suspended load on the crane	Uncontrolled entry of employees into the crane movement and working area, incomplete planned and breakdown maintenance works	Risk of falling parts, falling suspended load, crushing the worker as a result of movement	Loss of life, injury	Crane operators, truck drivers, truck drivers and shed workers	3	5	15	1

### 3.3 Risk Analysis Study on Container Stacking (Rtg Spreader) Work Machine

hazards arising from the rollers in the Mayna heave system. Risk analysis study on Container Stacking (Rtg Spreader) Work Machine is given in Table 3.

For Container Stacking (Rtg Spreader), with a rating of 1 and a risk value of 16, the highest activity is seen as

**Table 3.** Risk analysis study on container stacking (Rtg Spreader) work machine.

Activity	Danger	Root Cause of Danger	Risks Arising from Hazard	Impacts	Exposed Persons	Probability	Violence	Risk	Degree of Importance
Container stacking and loading	Vehicles and workers entering work machine walkways	Failure to sweep construction equipment walkways	Risk of collision of construction machinery and vehicles and crushing of workers	Material damage accident, loss of life, injury	Truck and lorry drivers, container yard workers	3	5	15	1
Container stacking and loading	Construction equipment system	Failure of the signaling system feeding the Agss system to work properly	Risk of the machine going off the road, hitting surrounding vehicles	Loss of life, injury	Construction equipment operators, vehicle drivers, port workers	2	5	10	2
Container stacking and loading	Diesel generator exhaust circuit	High temperature and toxic gases	Risk of injury and poisoning from the engine	Risk of injury from burns, risk of poisoning from inhalation of toxic exhaust gases	Operators, electricians, engine mechanics	3	5	15	1
Container stacking and loading	Reels in the Mayna heave system	Rotary moving parts, part drop into rtg working area	Risk of limb entrapment, risk of eye damage from fragments,	Injury	Port site workers, operators, truck drivers, tallymen	4	4	16	1
Container stacking and loading	Rtg Spreader	380 volt electrically moving chains and other rotating moving parts, falling parts of the spreader components into the rtg work area	Risk of electric shock during work, risk of limb entrapment in moving parts, risk of falling of broken parts	Injury	Engine mechanics, electricians, truck and truck drivers	3	4	12	2
Container stacking and loading	Planned maintenance and malfunctions not being eliminated on time	Inappropriate planned maintenance and troubleshooting	Risk of serious accidents due to improper maintenance	Accidents involving loss of life, injury, property damage	Rtgoperator, truck and lorry drivers	3	5	15	1

### 3.4 Handling Work Machine Risk Analysis Study

lifted by the machine. Risk analysis study on Handling Work Machine is given in Table 4.

For the Handling Work Machine, the highest activity with a rating of 1 and a risk value of 15 is seen as the hazards arising from workers entering under the load

**Table 4.** Risk analysis study on handling work machine.

Activity	Danger	Root Cause of Danger	Risks Arising from Hazard	Impacts	Exposed Persons	Probability	Violence	Risk	Degree of Importance
Loading and Unloading	Trucks, trucks and employees entering the handling machine work area	Personnel violating the working area of the crane	Risk of collision of machines and vehicles, risk of crushing workers	Material damage accident, loss of life, injury	Truck and lorry drivers, scaffolders, engine mechanics and electricians	3	5	15	1
Use of construction machinery for unloading and loading loads	Batteries on the construction machine	Splashing of acidic liquid in batteries into the body and eyes	Risk of acid in the eyes during battery inspection, risk of battery explosion, risk of electric shock	Loss of limb, injury	Electrical craftsmen, engine mechanics	3	2	6	3
Operations related to the electricity system	Handling machine electrical circuits	Starting work without taking appropriate precautions	Risk of electric shock	Injury	Electricity masters	3	2	6	3
Maintenance work	Maintenance work to be carried out in the hydraulic system of the handling machine	High hydraulic pressure, high hydraulic oil temperature	Risk of pressurized hydraulic fluid penetrating the skin, getting into the eyes	Injury	Motor mekanik ve elektrik ustaları	2	3	6	3
Maintenance and control works	Work to be done on the machine boom system	Height at which injury is likely in the event of a fall	Risk of falling due to working at height	Injury, loss of life	Engine mechanics, workshop foremen and electricians	2	5	10	2
Unloading and loading of cargo	Fast maneuvering of the handling machine operators with the work machine in the field	Exceeding the speed limits set at the port	Risk of collision with vehicles, risk of crushing the workers on board, risk of dropping the load on the scaffold, vehicles and ship	Loss of life, injury, material damagePort dock workers, truck-truck drivers, motor mechanics, ship workers	Port dock workers, truck-truck drivers, motor mechanics, ship workers	2	5	10	2
Loading and Unloading	Workers under the load lifted by the machine	Personnel violating the working area of the crane	Risk of burden on employees	Loss of life, injury	Port site workers, truck drivers, subcontractor employees	3	5	15	1
Part replacement	Replacements of attachments attached to the boom end of a handling machine	Unsuitable working environment	Risk of staff slip and fall	Injury	Engine mechanics	3	4	8	2
Loading and Unloading	Suspended load on crane	Personnel violating the working area of the crane	Risk of the suspended load falling, crushing the worker as a result of its movement	Loss of life, injury	Crane operators, truck drivers, truck drivers and shed workers	2	5	10	2

### 3.5 Stacker Work Machine Risk Analysis Study

For the Stacker Work Machine, the highest activity with a degree of 1 and a risk value of 20 is seen as the hazards arising from the fast maneuvering of the Stacker

operators with the work machine in the field and exceeding the specified speed limit. Risk analysis study on Stacker Work Machine is given in Table 5

**Table 5.** Risk analysis study on stacker work machine.

Activity	Danger	Root Cause of Danger	Risks Arising from Hazard	Impacts	Exposed Persons	Probability	Violence	Risk	Degree of Importance
Use of cranes in stacking	Trucks, lorries and employees entering the stacker work area	Occupation of stacker workspace	Risk of collision with vehicles and crushing of workers by construction equipment	Material damage accident, loss of life, injury	Truck and lorry drivers, container yard workers	3	5	15	1
Use of cranes in stacking	Stacker operators maneuvering fast with the work machine in the field, exceeding the set speed limit	Exceeding the set speed limit	Risk of accidents, risk of crushing personnel in the work area, risk of hitting cargo and containers	Loss of life, injury, material damage	Field workers, truck drivers	4	5	20	1
Use of cranes in stacking	The presence of workers or vehicles in the blind spot of the work machine during reverse maneuvering	Failure to see the area where the rear weight is located during reverse maneuvering with the construction machine	Risk of crushing of employees, risk of collision with passenger vehicles	Accident with material damage, loss of life	Field workers, truck drivers, passenger car drivers	3	5	15	1
Use of cranes in stacking	Lamps indicating the position of the spreader twistlocks not working properly	Use of construction machinery without repairing the faults	Risk of dropping the container, risk of damage to machinery and equipment	Accident with material damage, injury	Truck drivers, stacker operator	2	5	10	2



### 3.6 Tractor Work Machine Risk Analysis Study

For the Tractor Work Machine, the highest activity with a rating of 1 and a risk value of 16 is seen as hazards arising from the impact of limbs on the moving rotating

parts of the tractor in operation, getting stuck, etc. Risk analysis study on Tractor Work Machine is given in Table 6.

**Table 6.** Risk analysis study on tractor work machine.

Activity	Danger	Root Cause of Danger	Risks Arising from Hazard	Impacts	Exposed Persons	Probability	Violence	Risk	Degree of Importance
Fueling the tractor	Tractor fuel tank and fuel in the tank	Starting the fueling process without taking safety precautions	Explosion, fire	Loss of life, injury, property damage	Tractor operator, fuel dispenser, field workers, vehicle drivers	3	4	12	2
Maintenance work	Impact, jamming, etc. of limbs on moving rotating parts of the tractor in operation.	Rotary moving parts	Risk of injury or entrapment of limbs due to contact of body parts	Injury	Engine mechanics, Electricity masters	4	4	16	1
Maintenance work	Electrical circuits on the tractor work machine	Exposure to electric shock	Risk of electric shock	Injury	Electricity masters	3	4	12	2
Maintenance work to be performed on the tractor by the technical department	Pin removal operations on machine connection points	Hand tools used in maintenance or parts removed such as pins, bearings, etc.	Damage to the personnel performing the work due to swinging, dislocation, etc. of the apparatus used	Injury	Workshop masters, engine mechanics	2	4	8	2
Material transportation	Tractor water tanker attachment	Rapid maneuvering, the employee climbing on the tanker doing control work without taking the necessary safety precautions	Risk of overturning of the tanker, risk of falling of personnel climbing on the tank	Injury due to fall, accident with material damage	Tractor operator	2	4	8	2

## 4 Conclusions

Construction machinery has an importance that cannot be ignored today in working areas. The danger posed by construction machinery used in the industrial sector, which is the locomotive of the world economy, should not be overlooked. Operators with professional competence should be employed in construction sites, and construction machinery personnel working in construction sites should have an operator certificate related to the construction machinery they use. Operators should be trained on the dangers arising from machinery. The content of the trainings should cover accidents at world standards and emphasize the precautions to be taken. In addition, the contents of these trainings should also include occupational safety solutions applied at world standards. Occupational accidents are an important cost factor for employees and businesses and negatively affect employee and organizational productivity. Material and moral losses as a result of occupational accidents also cause great damage to the national economy. For this reason, it is necessary to identify the causes of occupational accidents in enterprises, to take the

necessary measures and to supervise them in order to work effectively and efficiently in a healthier and peaceful environment. When the results of our study are examined, it is seen that the most occupational accidents are experienced in loaders, the reason for this is that the daily working hours are more than 8 hours and the break times are not sufficient. Lack of certification and training of operators, irregularities in the working area, periodic maintenance and scrapping of work machines were seen as the main causes of occupational accidents. When the accident types were analyzed, it was determined that 17.4% of the accidents were caused by falling materials. Problems caused by inadequate performance of work machines were evaluated at a rate of 16.5%. Accidents occurring in case of non-compliance with occupational safety rules were determined at a rate of 13%. Problems caused by encountering irregular working area at the work site were determined at a rate of 18.7%. Problems arising from overheating and overloading of work machines were found to be 13%. Finally, problems caused by work pressure and stress in the workplace were found to be 21.4%. When we look at the statistics on occupational safety and health that emerged as a result of research on

working with construction machinery in our country, it shows improvement compared to previous years. Our study contributed to the literature by addressing the problems of construction equipment operators who are actively working in the field and statistically evaluating all the problems experienced not only in terms of occupational safety. As a result of our study, the importance of operator trainings, the organization of the working area, the importance of periodic maintenance of the work machine and the importance of controlling the effect of work stress have emerged. In the risk analysis study, the highest activity for forklifts with a severity level of 1 and a risk value of 20 is seen as the hazards caused by trucks, trucks and employees entering the forklift work area. For cranes, the highest activity with a severity level of 1 and a risk value of 15 is seen as the hazards arising from the crane getting off the rails and going off the road in the crane gantry walk from the activities of crane use in stacking. For Container Stacking (Rtg Spreader), the activity with a rating of 1 and a risk value of 16, the highest activity is hazards from the rollers in the Mayna lifting system. For Handling Work Machine, the activity with a rating of 1 and a risk value of 15, the highest activity is the hazards caused by the employees entering under the load lifted by the machine. For Stacker Work Machine, the highest activity with a degree of 1 and a risk value of 20 is seen as the dangers arising from the fast maneuvering of the stacker operators with the work machine in the field and exceeding the specified speed limit. For Tractor Work Machine, the activity with a degree of 1 and a risk value of 16, the highest activity is seen as hazards caused by limbs hitting the moving rotating parts of the tractor in operation, getting stuck, etc.

## Declaration

Ethics committee approval is not required.

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