MÜHENDİSLİK FAKÜLTESİ

Uluslararası Mühendislik Araştırma ve Geliştirme Dergisi
International Journal of Engineering Research and Development

UMAGD, (2022) 14(1), 45-57.

10.29137/umagd.937910

Cilt/Volume:14 Sayı/Issue:1 Ocak/January 2022

Araştırma Makalesi / Research Article

High-Risky Sectors in Terms of Work Accidents in Turkey

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***Başvuru/Received**: 17/05/2021 **Kabul / Accepted**: 23/07/2021 **Çevrimiçi Basım / Published Online:** 31/01/2022*
***Son Versiyon/Final Version**: 31/01/2022*

Abstract

Work accidents are serious issues that disrupt harmonious environment in workplace. They cause not only death, injury or disability of employees, but also serious financial loss for businesses and countries. Work accidents are highly preventable incidents, when necessary, precautions are taken. Like the whole world, in Turkey also there are risky sectors where work accidents are intensified. The identification of risky sectors in Turkey, is the first step of being able to fight against work accidents in this sector. Therefore, in this study the riskiest sectors in Turkey were investigated basing on the official accident data from the last ten years. Thus, first of all, the sectoral distribution of work accidents, death and permanent incapacity cases that occurred in Turkey in 2010-2019 was examined. Sectors were evaluated in terms of six different parameters: the number of work accidents, the number of deaths because of work accidents, the number of permanent incapacities because of work accidents, general accident incidence rate, fatal accident incidence rate, and permanent incapacity accident incidence rate. The top ten sectors with intensity have been determined for each parameter. Then, all these data were combined and the ten most risky sectors in Turkey in terms of work accidents were defined. In the last 10 years, the sector of "41-Building Construction" has been found to be the riskiest sector in Turkey, where the most work accidents have occurred, the most employees die and the most employees are permanently disabled. On the other hand, the "05- Mining of Coal and Lignite" sector, in which the general accident incidence rate, fatal accident incidence rate, and permanent incapacity accident incidence rate values are the highest, was the second most risky sector.

Keywords: *"Work Accidents, Risk, Risky Sectors, Building Construction, Turkey."*

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1. Introduction

Occupational accidents are unintentional and unexpected events that result from unsafe acts and conditions, resulting in death or property damage, or temporarily halt production and are mostly preventable with the proper precautions. The causes of work accidents are formulated with a **4M** approach. The 4M here comes from the first letters in the English words **M**an, **M**achine, **M**edia and **M**anagement. In other words, the causes of occupational accidents can be collected under four main headings. These are;

- ✓ Human causes (Man),
- ✓ Technical reasons arising from factors such as machinery, countertops and materials (Machine),
- ✓ Causes of environmental factors (Media),
- ✓ Reasons arising from disorders in management and organizational structure (Management).

As in Turkey, there are risky sectors in terms of occupational accidents in the world. The Construction, Mining and Transportation sectors are the most frequently experienced sectors of deaths in occupational accidents. However, the fact that the accident incidence rate values in countries where OHS measures are implemented effectively are much lower than in Turkey reveals how important OHS is in preventing accidents. The top three countries with the highest fatal accident incidence rate values in the world are India, Russia and Turkey. This situation is important for Turkey's OHS performance.

Although work accidents are an important problem for all countries, they can be distinctly prevented if the concept of Occupational Health and Safety (OHS) is applied correctly. The most important consequence of work accidents is the death, severe injury, limb loss or disability of employees. According to the International Labor Organization's (ILO) report "Safety and Health at the Heart of the Future of Work", each year 380.000 workers die in work accidents, while 374.000.000 workers are injured in non-fatal work accidents (ILO, 2019). Moreover, these figures tend to increase. Along this financially immeasurable cost that employees endure, there are also economic losses caused by work accidents. Again, according to ILO estimates, this financial loss is 4% of global gross domestic product. In countries where the OHS mechanism works well, these financial losses approach 1% of the country's gross product, while it can reach up to 6% in countries where the mechanism does not work well (ILO, 2019).

Turkey is one of the worst-performing countries in the world in terms of occupational safety. In comparison with European Union countries, it introduces the worst performance in terms of fatal accident incidence rate (İSGGM, 2020). Due to the unsafe and unhealthy working conditions people in Turkey also die. According to the Social Security Institution (SSI) work accident and occupational diseases statistics annuals, 422.463 work accidents occurred in Turkey in 2019, 1.147 employees died in these accidents, while 4.318 employees were permanently incapacitated or, in other words, became disabled for life (SSI, 2010-2019). Moreover, this data belongs only to known accidents that are recorded. According to the data of the OHS Council, the number of dead employees during work accidents in 2019 was at least 1.736. Official work accident data for 2020 has not yet been released by SSI. However, according to the OHS Council, 2.427 employees died in work accidents in 2020. This indicates that death cases because of work accidents tend to increase.

A scientific approach is needed to reduce deaths and permanent incapacity cases caused by work accidents. Scientists in Turkey have many studies on occupational health and safety. The most important studies among them will be interpreted here. In their studies Türen and Gökmen (2014) investigated the effects of the age factor on deaths as a result of work accidents and didn't find any meaningful and linear relationship between them. In their studies conducted in Izmir Province, Akboga and Baradan (2015) determined high-risk level factors by applying univariate frequency and cross tabulation analysis to fatal accidents occurring in 94 building sectors**.** Based on the work accidents that occurred between 2005 and 2016 in Turkey, Yağımlı and Ergin (2017) estimated the number of work accidents and the resulting deaths for 2017 with the exponential smoothing method. In another study, Yağımlı and Hacibektaşoglu (2018) estimated the number of accidents for 2016 by the exponential smoothing method using 2007-2015 SSI work accident data**.** In 2012-2016, Bilim et al. (2018) analyzed work accidents and occupational diseases in the mining sector together with the main and sub-sectors by comparing them with other sectors. Şimşek et al. (2020) in their case studies found that the probability of work accidents was reduced by 75% with the use of sensors in the risk assessment performed after the accident by using the 5x5 L type matrix method. Yağımlı and İzci (2017) estimated the data for 2016 with time series and smallest square methods using the number of deaths as the result of work accidents between 2008 and 2015 of the "Manufacture of Fabricated Metal products, Except Machinery and Equipment" sector in Turkey. In their studies, Viran and Barlas (2018) analyzed the sample accident with the formal safety assessment method and revealed determinations to reduce the factors based on the accident data in the closed area studies of the shipbuilding sector. Kazaz et al. (2016) interpreted the measures that can be applied by investigating the causes of work accidents occurring in the construction sector in Turkey. Based on accident data in the metal sector, Ayanoglu and Kurt (2019) created accident prediction models with multivariate data analysis methods and interpreted possible accident risks. In another study, Erginel and Toptancı (2017) tried to demonstrate measures relative to factors such as age and city using work accident data in the construction sector. In their research, Yardım et al. (2007) examined the current situation by calculating the mortality rates due to work accidents and occupational diseases between 2000 and 2005 using SSI data. Bilim and Çelik (2018) tried to reveal the status of the construction industry by making a sectoral analysis of work accidents between 2012 and 2016. Besides this, they determined the rate of work accident likelihood and evaluated the effect of the scale of the workplace on the accident probability. Öztürk and Eren (2019) investigated the impact of accident results on the same number of casualties on a sectoral basis by using the 2016 work accident statistics. Akyüz et al. (2019) compared work accidents and the number of deaths as a result of work accidents that occurred in Turkey and EU countries between 2008-2017. In another study, Şen et al. (2018) compared statistically the work accidents in Turkey and EU countries and found that Turkey was not sufficient in preventing fatal work accidents. Çoban and Kartal (2016) compared policies aimed at ensuring occupational health and safety in Turkey, England,

Germany, China and the USA and the number of fatal work accidents in countries between 2002 and 2013. Karadeniz (2012) study, it was emphasized that social protection is insufficient by basing on the work accidents and diseases data in the world and in Turkey. Using the work accident statistics for 2015, Erdugan and Türkan (2017) investigated whether there is any dependency between the variables of sector, gender and duration of incapacity for work. Taking advantage of work accidents examined by labor inspectors between 2007 and 2011, Kaplan and Kaplan (2019) determined the relationship level of factors such as age, gender, and education level. On the other hand, Ceylan (2012) analyzed the work accidents that occurred in the construction, mining, and metal sectors in Turkey between 2004-2010. In their work, Doğan et al. (2021) investigated a pier accident that occurred at the construction site and determined the necessary precautionary procedures to prevent similar accidents.

Turkey is performing very poorly in terms of OHS. Despite all the efforts made since 2003, the lack of a significant improvement in Turkey's OHS indicators and even the deterioration in some indicators such as the fatal accident incidence rate reveals that there is a systematic error in the OHS system. In this study, unlike the studies carried out in the literature, for the first time, the most important problem in Turkey's OHS mechanism is presented with a holistic approach. It is wrong to divide businesses into roughly 3 categories in terms of risk, as "less dangerous", "dangerous" and "very dangerous". Rather than that, it would be more effective to rank 88 distinct sectors in the official OHS database in terms of occupational accident risk and to develop sectorial measures to combat occupational accidents.

To prevent work accidents, it is necessary to establish an effective occupational safety mechanism. Classifying the sectors according to their risk levels, reviewing the correct system starting from the riskiest sectors to the least risky sectors and determining the necessary preventive measures would be a logical way to combat work accidents. In addition, determining the risk levels of sectors in terms of work accidents will also enable decision-makers to take additional measures specific to those sectors for very risky sectors. For this reason, in this study, 88 sectors are listed according to their risk levels in terms of work accidents in the SSI work accident and occupational diseases statistical annuals.

2. Basic Concepts

2.1. Work Accident

There are many definitions of work accidents in the literature. However, in Turkish legislation, the legal definition is mentioned in two places. The first of these is in the Occupational Health and Safety Law No. 6331. According to this definition, "the events that occur in the workplace or due to the execution of the work, that cause death or make the body integrity mentally or physically disabled" are called work accidents (6331 Sayılı İSG Kanunu, 2012). The second and main definition is in the Social Insurance and General Health Insurance Law numbered 5510. In this law work accident is defined as "When the insured is in the workplace, doing the work given by the employer, while working outside the workplace, going to work with a vehicle provided by the employer, or while the woman is on a breastfeeding leave, it is an event that causes immediate or later physical or mental disability to the insured." (5510 Sayılı Sosyal Sigortalar Kanunu, 2006)

2.2. Permanent Incapacity

It is the situation where the employee loses his / her earning power in the profession by at least 10% due to work accident or occupational disease (5510 Sayılı Sosyal Sigortalar Kanunu, 2006).

2.3. General Accident Incidence Rate

General Accident Incidence Rate is a benchmark used to compare countries, sectors with each other or any sector or country within itself in terms of work accidents over the years. *It shows the numbers of every 1000 people working in a calendar year are exposed to work accidents.* The formula is as follows (Ceylan, 2011).

$$\text{GAIR} = \frac{\text{NWA}}{\text{NE}} * 1.000 \qquad (I)$$

GAIR: General Accident Incidence Rate
NWA: Number of Work Accidents
NE: Number of Employees

2.4. Fatal Accident Incidence Rate

It is another benchmark used to compare countries and sectors in terms of work accidents. *It shows the number out of every 1.000.000 people working in a calendar year die because of a work accident.* The formula is as follows (Ceylan, 2011).

$$\text{FAIR} = \frac{\text{NFA}}{\text{NE}} * 1.000.000 \qquad (II)$$

FAIR: Fatal Accident Incidence Rate
NFA: Number of Fatal Accidents

2.5. Permanent Incapacity Accident Incidence Rate

It is the third benchmark used to compare countries and sectors in terms of work accidents. *It shows the number of every 1.000.000 people who work in a calendar year become permanently disabled because of a work accident.* The formula is as follows (Ceylan, 2011).

$$\text{PIAIR} = \frac{\text{NPIA}}{\text{NE}} * 1.000.000 \qquad (III)$$

PIAIR: Permanent Incapacity Accident Incidence Rate
NPIA: Number of Permanent Incapacities Accidents

3. Risky Sectors in Terms of Work Accidents

3.1. Methodology for Identifying Risky Sectors

Here, 25 sectors with the highest risk level in terms of work accidents were determined out of 88 sectors (Appendix-1) existing in SSI work accident and occupational diseases statistical annuals. The official data recorded by the SSI in the last ten years (2010-2019) as used for this purpose. Since the SSI 2020 statistical yearbook has not been published yet, it was not used in this study. According to official data, 2.360.442 work accidents have occurred in Turkey in the last 10 years, while 13.852 employees lost their lives in these accidents, and 29.144 employees became permanently incapable. In this study, the following sectors were found by analyzing the work accident data recorded in the last 10 years based on sectors:

- ✓ Top 10 sectors with the highest number of work accidents,
- ✓ Top 10 sectors with the highest number of fatal accidents,
- ✓ Top 10 sectors with the highest number of permanent incapacity cases,
- ✓ Top 10 sectors with the highest general accident incidence rate,
- ✓ Top 10 sectors with the highest fatal accident incidence rate,
- ✓ Top 10 sectors with the highest permanent incapacity accident incidence rate,

Later, according to Table-1, a risk score was assigned to the sectors ranked in the top 10 according to the six criteria above. By summing up the risk scores for each sector, 25 risky sectors in Turkey in terms of work accidents were determined.

Table 1. Risk Scores per Sectors

Sector	Risk Score
1. Sector	10
2. Sector	9
3. Sector	8
4. Sector	7
5. Sector	6
6. Sector	5
7. Sector	4
8. Sector	3
9. Sector	2
10. Sector	1

3.2. Sectors where Work Accidents are Intensified

In Table-2, the top ten sectors with the highest number of work accidents between 2010 and 2019 and the number of accidents is given. Table-3 shows the average of work accidents in these sectors for the last 10 years. If evaluate Table-2 and Table-3 together, approximately half of the accidents in the 2010-2019 period occurred in these 10 sectors. The top three sectors with the highest number of accidents "41-Construction of Buildings", "25-Manufacture of Fabricated Metal Products, Except Machinery and Equipment" and "10-Manufacture of Food Products", respectively.

Table 2. Sectors Where Work Accident Cases Are Intensified over the Years

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
TURKEY TOTAL	62903	69227	74871	191389	221336	241547	286068	359653	430985	422463
41-Construction of buildings	3056	3836	4511	14286	13508	15065	20159	34952	41759	25551
25- Manufacture of fabricated metal products, except machinery and equipment	6918	7268	7045	15699	18529	19221	20616	23627	25716	24085
10-Manufacture of food products	2422	2590	2972	9111	10971	12003	14351	20270	22610	22734
13-Manufacture of textiles	3474	3239	5127	10996	12128	12041	13446	16520	19573	20274
24- Manufacture of basic metals	4621	5272	4938	12061	12357	12529	13081	15670	17403	16413
56- Food and beverage service activities	856	1016	1310	6434	8818	10458	12626	16824	22487	25969
42-Civil engineering	1583	1718	1948	5917	7675	7903	9516	20873	27639	15927
23- Manufacture of other non-metallic mineral products	3861	4240	3733	9213	10244	10242	11721	14183	15622	13432
05- Mining of coal and lignite	8150	9217	8828	11289	10026	7429	8274	8468	8399	8983
81- Services to buildings and landscape activities	492	634	637	3082	6388	8972	11631	15188	17642	19683

Table 3. Top 10 Sectors with the Highest Number of Work Accident Cases (Average of 2010-2019)

	Average of 2010-2019	Its Share in All Accidents	Rank
TURKEY TOTAL	**236044**	**% 100**	
41- Construction of buildings	17668	% 7,5	1
25- Manufacture of fabricated metal products, except machinery and equipment	16872	% 7,1	2
10- Manufacture of food products	12003	% 5,1	3
13- Manufacture of textiles	11682	% 4,9	4
24- Manufacture of basic metals	11435	% 4,8	5
56- Food and beverage service activities	10680	% 4,5	6
42- Civil engineering	10070	% 4,3	7
23- Manufacture of other non-metallic mineral products	9649	% 4,1	8
05- Mining of coal and lignite	8906	% 3,8	9
81- Services to buildings and landscape activities	8435	% 3,6	10
TOP 10 INDUSTRY TOTALS	**117400**	**% 49,7**	

In Table-4, the first 10 sectors with the highest general accident incidence rate are given. While calculating the general accident incidence rate, the number of accidents in the sectors and the number of employees were found by taking the arithmetic average of the last 10 years. After, general accident incidence value of 88 sectors was calculated by using Equation-1. Table-4 is formed by listing the top 10 sectors with the highest general accident incidence rate. As understood from this table, the miners working in "05-Mining of Coal and Lignite" sector are the employees, who are frequently exposed to accidents in Turkey. Considering the averages of the last 10 years, while approximately 18 out of every thousand workers in Turkey were exposed to accidents, this rate is approximately 207 for the miners. These rates show that work accidents in the "05-Mining of Coal and Lignite" sector are about 11 times more intensive than the average of Turkey. In terms of general accident incidence rate, this sector is followed by "24-Manufacture of Basic Metals", "23-Manufacture of Other Non-metallic Mineral Products" and "25- Manufacture of Fabricated Metal Products, Except Machinery and Equipment" sectors, respectively. What is striking in this table is that the "41-Construction of Buildings" sector, which has experienced the most accidents in the last 10 years, has not been included in the list in terms of general accident incidence rate. The reason for this is that this sector is one of the sectors having the most employees among 88 sectors. Approximately 8% of all workers work in this sector. Therefore, the accident rate per 1000 workers decreases.

Table 4. Top 10 Sectors with the Highest General Accident Incidence Rate (Average of 2010-2019)

	General Accident Incidence Rate	Rank
TURKEY TOTAL	**18,22**	
05- Mining of coal and lignite	206,83	1
24- Manufacture of basic metals	72,95	2
23- Manufacture of other non-metallic mineral products	46,38	3
25- Manufacture of fabricated metal products, except machinery and equipment	45,61	4
29- Manufacture of motor vehicles, trailers and semi-trailers	44,23	5
22-Manufacture of rubber and plastic products	39,78	6
52- Warehousing and support activities for transportation	34,23	7
55-Accommodation	30,50	8
42-Civil engineering	30,12	9
10- Manufacture of food products	28,37	10

3.3. Sectors where Work Accident Death Cases are intensified

In Table-5, the top ten sectors with the highest number of fatal work accidents between 2010 and 2019 and the number of fatalities are given. Table-6 shows the average of death cases in these sectors for the last 10 years. If to interpret Table-5 and Table-6 together, approximately 65% of death cases in the 2010-2019 period occurred in these 10 sectors. The top three sectors with the highest number of deaths are "41-Construction of Buildings", "49-Land Transport and Transport via Pipelines" and "42-Civil Engineering", respectively.

Table 5. Sectors where Work Accident Death Cases are intensified over the years

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
TURKEY TOTAL	**1444**	**1700**	**744**	**1360**	**1626**	**1252**	**1405**	**1633**	**1541**	**1147**
41- Construction of buildings	264	304	127	296	260	239	239	340	360	207
49- Land transport and transport via pipelines	133	194	73	183	172	162	179	211	175	184
42- Civil engineering	107	118	66	121	143	124	130	158	162	105
43- Specialized construction activities	104	148	63	104	98	110	127	89	69	56
05- Mining of coal and lignite	86	55	20	36	335	26	11	31	11	13
23- Manufacture of other non-metallic mineral products	37	39	22	48	49	46	48	58	44	24
25- Manufacture of basic metals	43	72	25	35	31	37	27	36	48	31
46- Manufacture of basic metals	39	31	23	35	31	24	44	54	60	34
08- Other mining and quarrying	24	43	17	28	38	40	64	38	33	28
47- Retail trade, excluding motor vehicles and motorcycles	33	42	11	35	38	33	40	30	37	28

Table 6. Top 10 Sectors with the Highest Number of Work Accident Death Cases (2010-2019 Average)

	Average of 2010-2019	Share in All Cases	Rank
TURKEY TOTAL	**1385**	**% 100**	
41- Construction of buildings	264	% 19,1	1
49- Land transport and transport via pipelines	167	% 12,1	2
42- Civil engineering	123	% 8,9	3
43- Specialized construction activities	97	% 7,0	4
05- Mining of coal and lignite	62	% 4,5	5
23- Manufacture of other non-metallic mineral products	42	% 3,0	6
25- Manufacture of fabricated metal products, except machinery and equipment	39	% 2,8	7
46- Wholesale trade, except of motor vehicles and motorcycles	38	% 2,7	8
08- Other mining and quarrying	35	% 2,5	9
47- Retail trade, excluding motor vehicles and motorcycles	33	% 2,4	10
TOP 10 INDUSTRY TOTALS	**900**	**% 65**	

In Table-7, the first 10 sectors with the highest fatal accident incidence rate are given. Here, while calculating the fatal accident incidence rate, the number of death cases in the sectors and the number of employees were found by taking the arithmetic average of the last 10 years. Afterward, the fatal accident incidence rate of 88 sectors was calculated by using Equation-2. Table-7 is formed by listing the top 10 sectors with the highest fatal accident incidence rate. As understood from this table, the sector with the most frequent fatal accident rate in Turkey is the "05-Mining of Coal and Lignite" sector. Considering the averages of the last 10 years, while approximately 107 out of every million workers in Turkey die in work accidents, this rate is approximately 1440 for the miners. These values show that fatal accident cases in the "05-Mining of Coal and Lignite" sector are about 13 times more intensive than the average of Turkey. In terms of fatal accident incidence rate, this sector is followed by the "08-Other Mining and Quarrying", "42-Civil Engineering" and "49-Land Transport and Transport via Pipelines" sectors, respectively.

Table 7. Top 10 Sectors with the Highest Fatal Accidents Incidence Rate (Average of 2010-2019)

	Fatal Accident Incidence Rate	**Rank**
TURKEY TOTAL	**106,93**	
05- Mining of coal and lignite	1439,88	1
08- Other mining and quarrying	592,34	2
42- Civil engineering	367,90	3
49- Land transport and transport via pipelines	296,03	4
43- Specialized construction activities	294,61	5
41- Construction of buildings	251,03	6
23- Manufacture of other non-metallic mineral products	201,90	7
35- Electricity, gas, steam, and air conditioning supply	165,90	8
01- Vegetable and animal production, hunting and related service activities	162,96	9
24- Manufacture of basic metals	153,11	10

3.4. Sectors where Permanent Incapacity Cases Are Intensified due to Work Accidents

In Table-8, the top ten sectors with the highest number of permanent incapacity due to work accidents between 2010 and 2019 are given. Table-9 shows the average of the permanent incapacity cases experienced in these sectors for the last 10 years. If to interpret Table-8 and Table-9 together, we can see that approximately 58 % of the permanent incapacity cases experienced in the 2010-2019 period occurred in these 10 sectors. The top three sectors with the highest number of permanent incidents of incapacity are "41-Construction of Buildings", "25-Manufacture of Fabricated Metal Products, Except Machinery and Equipment" and "42-Civil Engineering", respectively.

Table 8. Sectors where permanent incapacity cases are intensified due to work accidents over the years

	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
TURKEY TOTAL	1976	2093	2036	1660	1421	3433	4447	3987	3773	4318
41- Construction of buildings	198	243	281	259	231	569	909	964	861	1029
25- Manufacture of fabricated metal products, except machinery	145	146	131	145	137	260	287	285	224	233
42- Civil engineering	62	73	101	70	58	213	300	314	290	357
43- Specialized construction activi	57	89	181	134	115	197	241	227	177	200
49- Land transport and transport v	58	64	82	75	67	162	182	168	184	268
23- Manufacture of other non-metallic mineral products	79	89	55	63	60	139	164	159	124	154
24- Manufacture of basic metals	40	56	71	63	47	135	178	152	128	129
13- Manufacture of textiles	62	69	70	67	55	100	145	117	96	145
10- Manufacture of food products	56	48	56	49	45	114	150	125	139	134
05- Mining of coal and lignite	50	81	67	54	60	101	145	81	54	71

Table 9. Top 10 Sectors with the Highest Number of Permanent Incapacity Cases due to Work Accidents (Average of 2010-2019)

	Average of 2010-2019	Share in All Cases	Rank
TURKEY TOTAL	2914	**% 100**	
41- Construction of buildings	554	% 19,0	1
25- Manufacture of fabricated metal products, except machinery and eq.	199	% 6,8	2
42- Civil engineering	184	% 6,3	3
43- Specialized construction activities	162	% 5,6	4
49- Land transport and transport via pipelines	131	% 4,5	5
23- Manufacture of other non-metallic mineral products	109	% 3,7	6
24- Manufacture of basic metals	100	% 3,4	7
13- Manufacture of textiles	93	% 3,2	8
10- Manufacture of food products	92	% 3,2	9
05- Mining of coal and lignite	76	% 2,6	10
TOP 10 INDUSTRY TOTALS	**1700**	**% 58,3**	

In Table-10, the top 10 sectors with the highest permanent incapacity accident incidence rate are given. Here, while calculating the fatal accident incidence rate, the number of permanent incapacity cases in the sectors and the number of employees were found by taking the arithmetic average of the last 10 years. Then, using Equation-3, the permanent incapacity accident incidence rate of 88 sectors was calculated. Table-10 is formed by listing the top 10 sectors with the highest permanent incapacity accident incidence rate. As understood from this table, the sector in which the most frequent incidents of incapacity due to work accidents are experienced in Turkey is the "05-Mining of Coal and Lignite" sector. Considering the averages of the last 10 years, approximately 225 out of every million employees in Turkey become incapable in work accidents, while this rate is approximately 1765 for the miners working in this sector. These rates show that permanent incapacity cases due to work accidents in the "05-Mining of Coal and Lignite" sector are approximately 8 times more intensive than the average in Turkey. In terms of the permanent incapacity accident incidence rate, this sector is followed by "16-Manufacture of Wood and of Products of Wood and Cork, Except Furniture; Manufacture of Articles of Straw and Plaiting Materials", "24-Manufacture of Basic Metals" and "42-Civil Engineering" respectively.

Table 10. Top 10 Sectors with The Highest Permanent Incapacity Accident Incidence Rate (Average of 2010-2019)

	Permanent Incapacity Accident Incidence Rate	Rank
TURKEY TOTAL	**224,98**	
05- Mining of coal and lignite	1765,02	1
16- Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	660,09	2
24- Manufacture of basic metals	637,96	3
42- Civil engineering	550,36	4
25- Manufacture of fabricated metal products, except machinery and equipment	538,01	5
41- Construction of buildings	526,78	6
23-Manufacture of other non-metallic mineral products	523,99	7
43- Specialized construction activities	492,03	8
31- Manufacture of furniture	431,78	9
22- Manufacture of rubber and plastic products	396,42	10

3.5. The Riskiest Sectors in Terms of Work Accidents in Turkey

The 10 riskiest sectors in terms of work accidents in Turkey are given in Table-11. Here, the methodology given in 3.1 was used while calculating the risk scores of the sectors. In other words, 10 risk points for the first place in the ranking, 9 risk points for the second place, and 1 risk point for the 10th place by decreasing it. As a result, the total risk score of that sector was found by summing the risk scores given for the 6 parameters seen in Table-11. Then, by listing the top 10 sectors with the highest risk score, Table-11 was created.

The riskiest sector in terms of work accidents in Turkey is the "41-Construction of Buildings" sector. The sector with the highest number of work accidents, accidents with fatal and permanent incapacity cases in Turkey is the "41-Construction of Buildings" sector. In addition, the sector that constitutes the construction sector "42-Civil Engineering" ranked 3rd place and the "43-Specialized Construction Activities" sector ranked as risky sectors from 7th place.

The second riskiest sector in terms of work accidents in Turkey is the "05-Mining of Coal and Lignite" sector. The sector with the highest incidence rate of general, fatal**,** and permanent incapacity accident in Turkey is the "05-Mining of Coal and Lignite" sector. In addition, another mining sector, "08-Other Mining and Quarrying", was ranked 9th.

One of the sectors listed in Table-11 is the "49-Land Transport and Transport via Pipelines" sector. This is the 2nd sector with the most fatal work accidents. In addition, it ranks 4th in the fatal accident incidence rate and 5th in the number of permanent incapacity cases. All this data reveals how risky this sector is in terms of work accidents.

Table 11. Top 10 Most Risky Sectors in Terms of Work Accidents in Turkey and Risk Scores per Sectors

	Accident Risk Score	**GAIR Risk Score**	**Death Risk Score**	**FAIR Risk Score**	**Permanent Incapacity Risk Score**	**PIAIR Risk Score**	**TOTAL RISK SCORE**
41- Construction of buildings	10		10	5	10	5	40
05- Mining of coal and lignite	2	10	6	10	1	10	39
42- Civil engineering	4	2	8	8	8	7	37
25- Manufacture of fabricated metal products, except machinery and equipment	9	7	4		9	6	35
23- Manufacture of other non-metallic mineral products	3	8	5	4	5	4	29
24- Manufacture of basic metals	6	9		1	4	8	28
43- Specialized construction activities			7	6	7	3	23
49- Specialized construction activities			9	7	6		22
08- Other mining and quarrying			2	9			11
10- Manufacture of food products	8				2		10

4. Conclusion, Discussion and Recommendations

In 2012, Occupational Health and Safety (OHS) law numbered 6331 was enacted in Turkey. Later, regulations on occupational health and safety were updated to combat work accidents more effectively. While what is expected from all these legal regulations was reducing work accidents with fatal and permanent incapacity cases, on the contrary, deterioration in all OHS indicators have been recorded after this date. For example, while 74.871 work accidents were recorded in 2012, 744 employees lost their lives in these accidents, and 2.036 employees became permanently disabled. According to the latest data of 2019, 422.463 work accidents occurred in 2019 and 1.147 employees died in the accidents, while 4.318 employees became permanently disabled (SGK, 2010-2019). All these data show that there is a serious deterioration in the OHS indicators of Turkey after the OHS law. This situation reveals that there is something failing in Turkey's OHS mechanism.

In Turkey, enterprises are divided into 3 categories: "Less Dangerous", "Dangerous" and "Very Dangerous" (İşyeri tehlike sınıfları tebliği, 2012). However, dividing all enterprises in Turkey into roughly 3 groups is not enough in terms of combating work accidents. All sectors should be examined in a detailed way, ranked according to risk levels as done here**,** and sectoral measures should be determined for high-risk sectors.

Hazard classes are used as the only separation standard for OHS services that organizations will provide to their employees in Turkey. All considerations and the validity periods, such as OHS services which a business will provide to its employees, will vary only depending on the hazard class to which that business is subject. However, the working conditions of two different enterprises that are in the same hazard class but operate in different sectors may considerably differ from each other. For this purpose, OHS mechanisms should be determined on a sectoral groundwork. In particular, the legislation should be reviewed for the "41-Construction of Buildings", "49-Land Transport and Transport via Pipelines", "42-Civil Engineering", 43-Specialized Construction Activities" and "5-Mining of Coal and Lignite" sectors that are prominent in fatal accidents. In addition, a special fighting tactic is needed for the risky sectors identified in this study in terms of the number of accidents and permanent incapacity cases.

Hundreds of thousands of work accidents are recorded every year in Turkey, not only because the legal legislation orders it, but also to see the failing aspects of the system and to fix it. Therefore, SSI work accident data should be examined and analyzed

regularly. For this purpose, all kinds of conveniences should be provided to all academicians and experts who want to work on this data.

The most important factor that causes the disruption of the OHS mechanism on a legal basis in Turkey is the way that the safety professionals are employed. Safety professionals who are in the position of an employer's member of staff are expected to audit that employer and report to the ministry if necessary. The anxiety of losing a job eliminates the professional independence of safety professionals. For this, the system of safety professionals must be completely evaluated.

Another problem with the OHS mechanism in Turkey is that people who are not experts in the main field of activity of the enterprise can become safety professionals in those very organizations. For instance, a biologist or chemist at a construction company could become a safety professional. To find the risks of a job, one needs to have the knowledge. Therefore, this system should be changed immediately; safety professionals should be assigned only to enterprises operating in their own areas of expertise.

Germany is one of the most successful countries in the world in terms of OHS performance. Its population is approximately the same as Turkey. Around one and a half million occupational accidents are recorded in Germany every year. As the number of registered work accidents in Turkey is around four hundred thousand, this means that a large part of the work accidents was not recorded.

Reporting occupational accidents to SSI within 3 working days is a legal obligation in Turkey. (6331 Sayılı İSG Kanunu, 2012). Declarations are made by the employer. SSI transfers the reported occupational accidents to a database and publishes them in the form of statistical annuals. From the statistical studies on this database, the failing aspects of Turkey's OHS mechanism are determined and useful information is produced for decision makers. Underreporting of occupational accidents casts a shadow on both the inability to measure Turkey's OHS performance correctly and the reliability of the information produced from the studies conducted on the Occupational Accident database.

Undoubtedly, an effective control mechanism is needed to prevent occupational accidents. Inspections on occupational health and safety in Turkey are carried out by labor inspectors affiliated to the Ministry of Labor and Social Security. Around 1000 labor inspectors work in Turkey since 2019. These labor inspectors carried out a total of 3088 inspections in 2019 (Table-12) (Çalışma Hayatı İstatistikleri, 2019). As of 2019, there are 1.891.512 workplaces and 14.314.313 workers in Turkey. Moreover, more than 600 thousand of these workplaces are in the "dangerous" and "very dangerous" categories. This shows that there is only one inspector for approximately 15.000 workers, and only 3088 of the nearly 2 million workplaces can be audited in terms of OHS. These data reveal that both the number of labor inspectors and the number of inspections are very, very insufficient. Increasing the number of labor inspectors firstly is a great importance in order to establish an effective inspection mechanism. In addition, the number of inspections should be made according the risk situation of the sectors. The sectors with the highest number of fatal occupational accidents in Turkey were the construction, transportation and mining sectors in 2019. In Table 12 we can see that only 77 inspections were made in the Transport sector, which is one of the sectors with the highest number of deaths. This shows that labor inspectors, whose numbers are already insufficient, were not utilized effectively.

Table 12. Occupational health and safety inspections by Sector, 2019

Sector	Total number of inspections
Metal	798
Construction	513
Commerce, office, education and fine arts	341
Textile, ready-made clothing and leather	223
Petroleum, chemicals, rubber, plastics and medicine	192
Mining and stone quarries	152
Transport	77
Others	792
General Total	3088

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Appendix-1: Classification of Sectors According to Economic Activities (NACE-2)

	NACE Code	Sector Name
1	01	Crop and animal production, hunting and related service activities
2	02	Forestry and logging
3	03	Fishing and aquaculture
4	05	Mining of coal and lignite
5	06	Extraction of crude petroleum and natural gas
6	07	Mining of metal ores
7	08	Other mining and quarrying
8	09	Mining support service activities
9	10	Manufacture of food products
10	11	Manufacture of beverages
11	12	Manufacture of tobacco products
12	13	Manufacture of textiles
13	14	Manufacture of wearing apparel
14	15	Manufacture of leather and related products
15	16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materi
16	17	Manufacture of paper and paper products
17	18	Printing and reproduction of recorded media
18	19	Manufacture of coke and refined petroleum products
19	20	Manufacture of chemicals and chemical products
20	21	Manufacture of basic pharmaceutical products and pharmaceutical preparations
21	22	Manufacture of rubber and plastic products
22	23	Manufacture of other non-metallic mineral products
23	24	Manufacture of basic metals
24	25	Manufacture of fabricated metal products, except machinery and equipment
25	26	Manufacture of computer, electronic and optical products
26	27	Manufacture of electrical equipment
27	28	Manufacture of machinery and equipment n.e.c.
28	29	Manufacture of motor vehicles, trailers and semi-trailers
29	30	Manufacture of other transport equipment
30	31	Manufacture of furniture
31	32	Other manufacturing
32	33	Repair and installation of machinery and equipment
33	35	Electricity, gas, steam and air conditioning supply
34	36	Water collection, treatment and supply
35	37	Sewerage
36	38	Waste collection, treatment and disposal activities; materials recovery
37	39	Remediation activities and other waste management services
38	41	Construction of buildings
39	42	Civil engineering
40	43	Specialized construction activities
41	45	Wholesale and retail trade and repair of motor vehicles and motorcycles
42	46	Wholesale trade, except of motor vehicles and motorcycles

43	47	Retail trade, except of motor vehicles and motorcycles
44	49	Land transport and transport via pipelines
45	50	Water transport
46	51	Air transport
47	52	Warehousing and support activities for transportation
48	53	Postal and courier activities
49	55	Accommodation
50	56	Food and beverage service activities
51	58	Publishing activities
52	59	Motion picture, video and television program production, sound recording and music publishing activities
53	60	Programming and broadcasting activities
54	61	Telecommunications
55	62	Computer programming, consultancy and related activities
56	63	Information service activities
57	64	Financial service activities, except insurance and pension funding
58	65	Insurance, reinsurance and pension funding, except compulsory social security
59	66	Activities auxiliary to financial services and insurance activities
60	68	Real estate activities
61	69	Legal and accounting activities
62	70	Activities of head offices; management consultancy activities
63	71	Architectural and engineering activities; technical testing and analysis
64	72	Scientific research and development
65	73	Advertising and market research
66	74	Other professional, scientific and technical activities
67	75	Veterinary activities
68	77	Rental and leasing activities
69	78	Employment activities
70	79	Travel agency, tour operator and other reservation service and related activities
71	80	Security and investigation activities
72	81	Services to buildings and landscape activities
73	82	Office administrative, office support and other business support activities
74	84	Public administration and defense; compulsory social security
75	85	Education
76	86	Human health activities
77	87	Residential care activities
78	88	Social work activities without accommodation
79	90	Creative, arts and entertainment activities
80	91	Libraries, archives, museums and other cultural activities
81	92	Gambling and betting activities
82	93	Sports activities and amusement and recreation activities
83	94	Activities of membership organizations
84	95	Repair of computers and personal and household goods
85	96	Other personal service activities
86	97	Activities of households as employers of domestic personnel
87	98	Undifferentiated goods- and services-producing activities of private households for own use
88	99	Activities of extraterritorial organizations and bodies