



Assessment of hazards and risks in glass products production and processing business during the pandemic

Pandemi sürecinde cam ürünleri üretim ve işleme işletmelerinde tehlike ve risklerin değerlendirilmesi

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Abstract

In this study, the hazards in a medium-sized enterprise engaged in production and processing of glass products in Turkey and the risks they pose are identified. Then, using cross-sectional research, a physical, chemical and biological risk report was created by L-type matrix method. During this reporting, hazards caused by Covid-19, which has been declared as pandemic by World Health Organization and became the biggest health problem in the world today, and regulatory and preventive actions that can be taken against these hazards are widely covered. The aim of the study is to contribute to the industry in terms of taking measures against occupational accidents and diseases.

Anahtar kelimeler: Glass industry, Occupational safety, Hazard, Risk analysis, Covid-19, Pandemic

1 Introduction

Throughout their journey of survival in the cycle of life, people have to perform some certain actions mandated by the life itself such as working, producing, having fun and exercising. Observed in every aspect of life, the role and the significance of "safety" in working life date back to the beginning of the mechanized industrialization in Europe during the 18th and 19th centuries. As a result of the analysis of the occupational accidents and diseases experienced at the beginning of the industrialization era, certain measures taken to prevent the recurrence of such have lead the process to a reactive course of actions. Taking the occupational accidents and occupational diseases occurring through the course of the mechanization process into consideration, the concept of occupational safety becomes prominent and have lead into changes in design of the machines. Every change brings about the prevention culture and the process is ensured to be proactive. When industrialization in the world is analyzed, from the very beginning until today, the concept of safety culture has developed through its natural course and works have been conducted in order to create a safe working environment in light of technological advances [1].

Occupational Health and Safety (OHS) has taken its place among important concepts of today's business life. Works conducted and steps taken in the OHS field have

Özet

Bu çalışmada, Türkiye'de cam ürünleri üretimi ve işlemesi yapan orta ölçekli bir işletmedeki tehlikeler ve bunların oluşturduğu riskler tespit edilmiştir. Daha sonra kesitsel araştırma kullanılarak L tipi matris yöntemi ile fiziksel, kimyasal ve biyolojik bir risk raporu oluşturulmuştur. Bu raporlama sırasında Dünya Sağlık Örgütü tarafından pandemi ilan edilen ve bugün dünyanın en büyük sağlık sorunu haline gelen Covid-19'un neden olduğu tehlikeler ve bu tehlikelere karşı alınabilecek düzenleyici ve önleyici tedbirler geniş kapsamlı olarak ele alınmaktadır. Çalışmanın amacı, iş kazası ve meslek hastalıklarına karşı önlem alma konusunda sektörle katkı sağlamak.

Keywords: Cam endüstrisi, İş güvenliği, Tehlike, Risk analizi, Covid-19, Pandemi

positive impacts on the change in safety culture. OHS professionals focus on adult training and habit-breaking subjects, thus making significant contributions to the awareness-raising and the improvement of safety culture levels of employees. The involvement of workers in activities such as trainings, improper implementations detected during audits, risk assessments of workers plays an active role in the prevention of occupational accidents and diseases. With the OHS Law no. 6331 (OHS Law) going into effect, OHS-related works conducted almost in all industries in Turkey have accelerated, and statistics have started to be followed on a sectoral basis. Following the enforcement of OHS Law no. 6331, reactive methods have been replaced by proactive methods. Proactive approach is a system that aims to prevent possible accidents and diseases by determining the hazards in the activities carried out in the work environment in advance. As an output of this system, it is aimed to take measures against the risks posed by hazards in the work environment analyzed, and to prevent the possible accidents and diseases by analyzing in advance. There are many different methods developed and implemented in terms of hazard and risk identification. As a result of the implementation of these methods, a corrective and preventive approach was adopted rather than a prescriptive approach [2].

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As of 1990s, numerous studies have been conducted in terms of hazards and risks which may be encountered by glass industry workers. Some of these studies have been conducted on the risk of cancer among glass factory workers [3], occupational glass injury risk of bar staff [4], diabetic and arsenic-based health problems of artistic glass workers [5-8], injuries at glass bottle production facilities [9], exposure to occupational styrene in glass fiber reinforced plastic industry and skin diseases [10, 11], review and meta-analysis of risks related to rockwool and glass wool exposure of lung, head and neck cancers [12].

Glass industry with all of its sub-industries is a sector in hazardous and very hazardous class due to chemical raw materials, work equipment used during production, Covid-19 which has become today's biggest health problem as well as physical, chemical and biological hazards, and it harbors significant hazards and relevant risks in terms of OHS. In this study; hazards within the work environments of glass and glass product enterprises, the risks they may create are identified, risk analysis of the enterprise is created using L-type matrix risk assessment method, and recommendations and actions required for measures to be taken are defined.

2 Glass and glass products industry

Glass is one of the oldest forms of artificial materials discovered by humankind. During the prehistoric ages, humans used volcanic glass, found in nature, to construct arrowheads and cutting tools although they did have the knowledge of how glass was produced. The first glass produced by humans is thought to be the beads made in Mesopotamia and Egypt in 2500 BC [13].

While almost all kinds of glass products were handcrafted until the end of the 19th century [14], today, all glassworks except certain special parts are produced by machines. Glass, thanks to its natural state of transparency, constant volume, odorless and tasteless form, and resistance to numerous chemicals is an industrial field that provides input to almost all industries such as food, beverage, medicine, cosmetics, architecture, health, automotive,

construction, communication, white goods, machinery, furniture, electric-electronics and glassware.

Glass industry production capacity in Turkey is approximately 3.5 million tons. The industry, supplying almost all of its production inputs from domestic sources, is obliged to maintain its energetic, intensive and high-capacity operation activities with its production value of approximately 2 billion dollars and 20 thousand employees [15].

3 Place of glass and glass products production in Turkey

Turkish Glass Industry, founded in 1934 upon the order of Atatürk, has increased its production capacity day by day in parallel with technological advances, and become one of the most significant branches of Turkish manufacturing industry today thanks to its product quality, increasing export figures and being an industry, which supplies all of its production inputs from domestic sources.

5-years import and export figures for glass and glassware products are given below. Turkey's top export items are tableware, ornaments, flat glass and fibers. According to 2023 Export Strategy of Turkey Exporters Assembly, 2023 export target for glass and glass products industry is 2.5 billion dollars [15]. It is estimated that global annual glass production capacity is approximately 180 million tons and has a value of approximately 130-140 billion dollars. Global glass industry grows between 2-4% on average every year based on the advances in the global economy. 53% of this belongs to glass packages, 29% to flat glass, 5% glass houseware, 2% to glass fiber and 11% to other products [15].

Table 1 shows glass and glass products import figures between 2013-2019. According to this, most of the imports are made from China. China is followed by Germany and Bulgaria. Import of glass items from China, solely, is more than the total of import from the subsequent countries.

Table 2 shows export figures of glass and glass products industry. Germany is in the first place, followed by Italy, USA and France. Despite ranking the first in 2015 and 2016, Italy dropped to the second place in 2017 and 2018.

Table 1. Countries from which Turkey imports glass products and import amounts (1000 USD) [16]

Imported Countries	Yearly Import Amounts						
	2013	2014	2015	2016	2017	2018	2019
China	237.581	238.476	223.749	202.222	185.235	164.474	146.118
Germany	78.179	84.057	71.809	73.456	80.100	85.832	79.225
Bulgaria	25.815	36.413	43.465	51.264	61.793	64.822	43.733
Italy	42.765	63.912	45.284	52.720	68.368	58.695	53.105
France	47.816	48.398	45.606	47.017	51.137	51.143	53.254
USA	32.341	37.881	42.858	39.434	50.253	47.058	37.270

Table 2. Countries to which Turkey exports glass products and export amounts (1000 USD) [16]

Exported Countries	Yearly Export Amounts						
	2013	2014	2015	2016	2017	2018	2019
Germany	103.519	115.313	89.760	84.898	90.955	92.161	85.670
Italy	59.333	60.901	160.220	120.960	60.403	71.908	91.813
USA	38.801	46.765	42.870	42.688	44.023	47.717	53.796
France	57.537	55.265	59.654	49.842	42.902	47.543	50.705
United Kingdom	55.153	59.186	82.914	46.705	54.034	47.369	57.558
Israel	35.078	40.467	37.671	40.436	39.794	47.089	58.035

4 Risk assessment methods

The word “risk” derives from the words risq in Arabic or risicum in Latin [17]. According to [18], risk is the probability of not achieving a targeted result or probability of the occurrence of an undesired incident, and uncertainties are potential sources of risk [18]. Risk is an objective concept related to the uncertainty of occurrence of unwanted incidents [18]. Throughout years, various risk assessment models have been conceptualized in order to elucidate the concept of the safety risk assessment [19,20]. Through proactive approach, risk assessments are performed at enterprises in order to identify the risks and take the required measures before the accident occurs [21, 22].

Following are the different (qualitative, quantitative and mixed) risk assessment methods applied in calculation of risk score [23]:

- Process Hazard Analysis (PHA)
- Probabilistic Risk Assessment (PRA)
- Probabilistic Risk Assessment Using Checklist (PRA Using Checklist)
- Fine - Kinney Method
- Safety Audit
- Rapid Ranking Methodology
- Job Safety Analysis (JSA)
- Canonical-Correlation Analysis (CCA)
- Failure Mode and Effects Analysis Methodology (FMEA)
- Event Tree Analysis (ETA)
- What If Analysis (What If)
- Risk Assessment Decision Matrix Methodology (L-shaped, X-shaped)
- Risk Map
- Hazard Rating Method (DOW, MOND Index)
- Hazard and Operability Study Methodology (HAZOP)

4.1 L-type matrix method

Statistics of occupational diseases and accidents in the industry, field workers and OHS professionals are used in order to assess the hazards and risks encountered in glass and glass products production. In conclusion, it has been observed that employees are exposed to physical, chemical, biological, psychosocial, ergonomic hazards and risks along the line from the raw material preparation stage until the shipping process.

In L-type matrix risk assessment method, it is aimed to reach the risk score result by assessing the probability of the hazardous situation along with the impact of the damage. Corrective and preventive actions are implemented in accordance with the equivalent of the risk score, which is found as a result of mathematical multiplication of the values obtained, in the score table [14].

Values indicating the probability and severity of the incident or hazardous situation subject to the assessment are selected from Table 3, multiplied, and the result determines the risk score.

Table 3 indicates how to value and score the ranking/severity and the probability of risks when conducting a risk analysis. Risks that do not cause incapacity or require first aid are assessed as very light in terms of ranking/severity and scored 1, while situations that may require first aid or outpatient treatment are considered light and scored 2. Death and mass death events are ranked as very serious and scored 5. Probability of risks that almost never occur are defined as highly unlikely and given 1 as the score while risks that occur every day or once a week are identified as very likely and assessed with a score of 5.

4.2 Risk score assessment

Concepts to be used for risk score assessment can be defined as follows:

Risk: Probability of loss, injury or other harmful results caused by the hazard.

Risk Score: Value found as a result of mathematical multiplication of probability, frequency and severity.

Severity: Severity of results in case of an accident.

Hazard: Potential of causing loss or damage, either originating from the workplace itself or the outer environment, that may affect the worker or workplace [25].

Assessment of resultant risk [26] score is conducted according to Table 4 and Table 5, and corrective and preventive actions are taken. As seen in Table 4, risk score is obtained by multiplying risk rating/severity and probability values. For instance, score of a risk with moderate rating/severity and moderate probability is found to be $3 \times 3 = 9$. The score found is assessed as seen in Table 5. This table shows the rating of risk and the resulting assessment accordingly. The higher risk score, the more important the actions to be taken. If risk score is 25 as a result of the actions taken, it is assessed as “unacceptable risk”. In this case, required measures must be taken immediately, or it must be considered to close the facility, building and environment. If the risk score is between 1 and 5, it is considered as “probable risk” and observation practices continue

4.3 Identification of hazards and risks

Glass industry is in “very hazardous” class due to its production stages and the chemical substances used. Glass is broken or crushed during the raw material preparation stage and concentrated in blend preparation section. This is where, glass and other various alloy elements and chemical substances interfuse. Measures must be taken against chemical dusts that may be released in this process. Release of these dusts to the environment may cause lung disease. The blend in solid phase prepared during fusion stage is transformed to liquid phase and given the capability to change form. In this stage, various measures must be taken against thermal comfort conditions and chemical vapor. Materials coming out of the kiln are shaped by pressure or force in the forming unit, checked after cooling process, and sent to the warehouse. Each stage has its own specific hazards and risks [15].

Table 3. Table for rating/severity and probability values in risk analysis [24]

Ranking / Severity			Probability	
1 Very Light	Does not cause incapacity or require first aid.	1 Very Low	Not expected to occur during the process. Sufficient control is ensured. (Almost never)	
2 Light	Situations that may require first aid, outpatient treatment.	2 Low	It is thought that the probability during the process is eliminated. Control system available. (Once in a few years)	
3 Moderate	Injuries requiring treatment, inpatient treatment, short-term incapacity.	3 Moderate	Probable to occur during the process, however it is not expected. Its uncontrollability is a very slight probability. (Once or twice a year)	
4 Serious	Sever injuries, loss of limb, occupational disease, continuous incapacity.	4 High	Likely to occur during the process. Its controllability is not certain, or controls might be limited and insufficient (Once a month)	
5 Very Serious	Death, Mass Death.	5 Very High	Expected to occur during the process. No control system. (Once a week/Every day)	

Table 4. Risk score assessment [24]

		Ranking / Severity				
		Very Serious 5	Serious 4	Moderate 3	Light 2	Very Light 1
Probability	Very High 5	Unacceptable 25	High 20	High 15	Moderate 10	Moderate 5
	High 4	High 20	High 16	Moderate 12	Moderate 8	Low 4
	Moderate 3	High 15	Moderate 12	Moderate 9	Moderate 6	Low 3
	Low 2	Moderate 10	Moderate 8	Moderate 6	Low 4	Low 2
	Very Low 1	Moderate 5	Low 4	Low 3	Low 2	Irrelevant 1

Table 5. Risk assessment results [24]

Risk Value	Risk Ranking	Risk Assessment Result
$x = 25$	1st Degree	Unacceptable risk required measures must be taken immediately / or it must be considered to close the facility, building and environment
$12 < x < 25$	2nd Degree	Very important risk must be improved in the short run (within a few months)
$6 < x < 15$	3rd Degree	Important risk must be improved in the long run (within the year)
$1 < x < 15$	4th Degree	Probable risk must be implemented under surveillance
$x = 1$	5th Degree	Unimportant risk measures are non-priority

Required safety measures must be taken for chemicals used in glass production, and material safety data forms (MSDSs) of chemicals must be obtained. Forced and natural ventilation systems must be used in areas where toxic chemicals which are harmful for respiration are processed, environmental measures must be performed in required intervals. Appropriate mask use must be ensured in sections where there is no sufficient ventilation and dusty areas. Combustible and caustic materials must not be placed in the same environment, employees must be trained against possible fires, and appropriate fire extinguishers must be provided. Noisy work areas must be isolated from other departments, and appropriate protective earpieces must be used by employees exposed to noise. Working hours of employees exposed to continuous loud noises must be

regulated and suitable resting breaks must be scheduled [27]. Appropriate personal protection gears must be provided and used in order to protect employees during processes where the glass is formed by blowing. Appropriate heatproof and noncombustible gloves must be provided to persons who are constantly exposed to high temperatures, and direct contact of eyes and skin with heat must be avoided. Employees must hydrate sufficiently and working hours must be regulated appropriately. Ventilation and cooling systems must be constructed suitably [28]. Relevant training must be provided, and suitable transport vehicles must be used in order to prevent accidents that may occur during the conveyance of materials. Appropriate gloves, clothes, and face protector's resistant to cutting must be used in order to be protected from "cutting" feature of broken glass, and

manual handling procedures must be replaced with automation system as much as possible [14].

4.4 Risk factors

When we take a look at the risks that may occur after the hazards arising within the scope of occupational health and safety, risk factors may be listed as follows [28]:

- **Physical risk factors:** Noise, vibration, lighting, heat, humidity, dusts, radiation, pressure, etc.
- **Chemical risk factors:** Mines, solvents, toxic gases, acid and alkalis, pesticides, plastic substances, dusts, etc.
- **Biological risk factors:** Bacteria, viruses, parasites, brucella, anthrax, plague, tularemia, etc.
- **Psychosocial risk factors:** Job security, future concerns, long working hours, work stress, severity, time pressure, job dissatisfaction, monotone work, rareness of resting breaks, etc.
- **Ergonomic risk factors:** Physiology of the work, heavy load handling and lifting, etc.

4.4.1 Physical risk factors

Valve actuator devices, mixer engines, vibrators, dust collectors and blowing machines operating with loud noises are machines that are frequently used in glass production. Workers who use or work in the vicinity of these machinery may experience loss of hearing due to noise when they are exposed to loud noise for a long time [29].

Since fusion process is generally conducted in closed-system furnaces, there are no employees in this section where this process takes place. However, since molten glass is taken out from kilns to be processed in enterprises conducting manual production, employees may be exposed to high temperatures [30]. Severe burns may occur on the skin due to high temperatures. Infrared lights may harm the eyes if measures are not taken, also the risk of cataract increases for people who are exposed to this heat for a long time. In addition, people who are exposed to high temperatures for a long time may experience heat strokes. Heat stroke may cause fatigue, drop in blood pressure, nausea, vomiting as well as fever, respiratory failure, and loss of consciousness in later stages. High temperature may also cause attention deficit of the employee and thus may lead to occupational accidents [31].

Since cooling process is performed on automated belts, the risks in this section are relatively less than others. However, noise exposure is also very high in this section.

Employees may experience musculoskeletal system disorders during packaging and transport of glasses produced with different forms and weights. In this section, especially glass shards pose risks. Also, there may be risks caused by forklifts and pallet trucks used for transport.

4.4.2 Chemical risk factors

There are numerous chemical compounds bearing features of glass. Breathing the air contaminated with the vapor of chemicals used in glass production such as silica, clay, limestone, aluminum oxide, and heavy metals might cause health-related hazards can cause health problems.

Paints used during changing the color of the glass vaporize more since they are applied on hot glass. Respiration of vaporized chemicals may cause pneumoconiosis and lung diseases. The risk of lung cancer increases in employees who have been exposed to vapors of chemicals for long years [31].

The process during which the glass is rapidly crushed to an abrasive and hard ground in order to smooth out or swell the glass surface is called blasting. During blasting, silica crystals are mixed into the air and may cause silicosis in lungs as a result of the air breathed. Heavy metals are added to the mixture used for production of frit and coloring of the frit. Respiration of the metal smoke may cause lead poisoning. A person who suffers from lead poisoning may experience anemia, headache and even coma and death in later stages. In glass material production where the glass is shaped by blowing, the blower may be exposed to chemical vapors. The blower may experience kidney function deformations and respiratory tract diseases such as bronchopneumonia and bronchitis as a result of inhaling metals such as mercury [32].

Despite majority of the process is performed by automated system in large-scale production factories, these kinds of exposures are experienced while taking samples from production, during repairment of system failures, and as a result of employee faults and unavoidable accidents.

4.4.3 Biological risk factors

In crowded enterprises where the number of employees is high, biological hazards are risk factors required to be taken into consideration. Biological agents include bacteria, viruses, fungi, other microorganisms and related toxins. These organisms which are (or products of) living creatures are generally found in natural environments such as water, soil, plants and animals. When talking about biological risk factors in working life, microorganisms, cell cultures and human parasites which may cause any infection, allergy or poisoning (including genetically modified ones) come to mind [33, 34].

European Directive 2000/54/CE classifies biological hazards (pathogens) into four groups based on infection risk level [35]:

- Group 1:* Unlikely to cause human disease;
- Group 2:* Can cause human disease and might be a hazard to workers; unlikely to spread to the community; there is usually effective prophylaxis or treatment available;
- Group 3:* Can cause severe human disease and present a serious hazard to workers; it may present a risk of spreading to the community, but there is usually effective prophylaxis or treatment available;
- Group 4:* Causes severe human disease and is a serious hazard to workers; it may present a high risk of spreading to the community; there is usually no effective prophylaxis or treatment available.

Under *Group 3*, Covid-19 pandemic, which is thought to be originated from Huanan Seafood and Live Animal Market in Wuhan city of Hubei state of China in December 2019 for the first time and has caused a pandemic

throughout the world, continues to pose vital threats [36]. These risks caused by the pandemic affect the whole world, thus negatively changing the working life in our country too. Certain hazards caused by Covid-19 and corrective and preventive actions that can be taken against these hazards are given in [Table 6](#).

4.4.4 Psychosocial risk factors

It has been observed that identification and diagnosis of psychosocial risk factors in workplaces is difficult, it is challenging to access previous records, and even when accessed, very limited in Social Security Institution. It is difficult to diagnose occupational diseases based on psychosocial factors. Because, establishing causal relation between the disease and the work or the working environment, and understanding whether it is caused by the occupation is a rather difficult process compared to other diseases [37].

Psychosocial factors include subjects such as relationships between people in a workplace, relations of employees with each other, with foremen, headmen and directors, management form and renumeration policy of the workplace. Also, work stress and similar issues caused by heavy, repetitive and monotone works can be examined under this title. Primary psychosocial factors include stress, which is described as the disease of our age by certain circles, as well as conflicts and organizational factors (working hours, shifts, etc.) [38].

4.4.5 Ergonomic risk factors

Ergonomics is defined as designing workplaces, equipment, machinery, apparatus, products, environments and systems appropriate for the employee by optimizing the efficiency and effectiveness of work systems, taking into consideration physical, physiological, biomechanical and psychological characteristics of humans [39, 40].

5 Research methods and results

In this study, a medium-scale enterprise engaged in the production and processing of glass products in Turkey is examined cross-sectionally [41]. Prior to the study, a risk analysis team was established consisting of one head labor inspector, two class A occupational safety specialists, two class B occupational safety specialists, one workplace physician and employer representative, employee representative, head of the department, and supporting staff. Risk analysis methods were examined with team members, and the L-type matrix risk analysis method was preferred as the risk analysis method to be applied in the workplace. Information related to the L-type matrix risk analysis was conveyed to team members through training, afterwards, field inspections were conducted and required statistical

data was collected for a month. Near miss incidents and accident reports of the subject enterprise were examined in detail by team members. The findings obtained were assessed in accordance with the L-type matrix risk analysis method, and risk analysis of the firm was created. Required measures were taken, field observations were repeated, and risk analysis was revised following this risk analysis.

[Table 6](#) identifies the hazard sources in the enterprise and reveals the risks that may be caused by these hazards. In the resulting risk analysis, 37 activities with the highest risk score are listed. Probability, severity, and risk scores are shown based on existing conditions in these cases. Priorities are detected based on scores, and recommendations about the measures to be taken are listed. Risk scores of activities numbered 1, 2, 3, 4, 5, 6 and 7 are found to be 25. Immediate measures must be taken for identified hazards. Risk scores of other activities given in the table are found to be 15-20. Recommendations are provided, and measures to be taken are identified also for these activities.

6 Conclusion

Hazards and risks based on physical, chemical and biological factors which the employees can be exposed to during the production process of an enterprise engaged in glass and glass products industry were identified. The risks identified were proactively assessed, and corrective and preventive measures were identified for each activity. Preventive and corrective actions identified for 37 activities with high risk scores as a result of the study must be immediately processed, and a probable unwanted situation must be prevented. Among the hazards identified in the table, it has been found that hazards such as pandemic, electrical panels, machinery, moving parts, working at height, chemical substances and fire had the highest risk scores. In order to prevent occupational accidents before they happen, measures required to be taken in terms of activities centered around people must be realized immediately. Therefore, actions must be taken with the motto "*People First*", and risks must be eliminated at source before they occur. In conclusion, the study conducted is significant as it constitutes a leading model for enterprises engaged in glass and glass products industry and scientists who will conduct studies in this field.

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Conflict of interest

The authors declare no conflicts of interest.

Similarity Rate (iThenticate): 8%

Table 6. Risk assessment with L-type matrix method (P: Probability, S: Severity, RS: Risk score)

No	Department	Hazard	*Probability / **Risk	Current Situation	P	S	RS	Recommendations/Measures to be Taken
1	General	Coronavirus pandemic	*Exposure to coronavirus pandemic. **Infection, disability, death.	Covid-19 virus, which spreads very rapidly, has been declared a pandemic by World Health Organization (WHO).	5	5	25	Employees and visitors (37.5 °C and above) must be prevented from entering the enterprise and referred to the nearest health institution. Infrared, contactless temperature meter must be used to take temperature at the enterprise.
2	General	PPEs which are not sufficient or appropriate for coronavirus pandemic and lack of disinfectants in stocks	*Exposure to coronavirus pandemic. **Infection, disability, death.	It has been found that masks are used, however are not replaced periodically.	5	5	25	It is required to increase stocks of masks (TS EN95, EN149, FFP2, FFP3), gloves (latex gloves, EN ISO 374-5), bleach, alcohol, cologne (80 degrees), hand disinfectants.
3	General	Not respecting individual safe distance or close contact due to coronavirus pandemic	*Exposure to coronavirus pandemic. **Infection, disability, death.	It has been found that employees do not respect social distance rules in the cafeteria.	5	5	25	In cases people are present collectively (trainings, meetings, dinners, etc.), procedures must be implemented to ensure that there is at least 1,5 m distance between employees.
4	General	Lack of hygiene training of employees	*Exposure to coronavirus pandemic. **Infection, disability, death.	It has been understood that the employees were not given required trainings in terms of pandemic process.	5	5	25	Hygiene training must be compulsory for employees, and employees who did not receive these trainings must not work.
5	General	Employees over 65 and with chronic diseases due to coronavirus pandemic	*Exposure to coronavirus pandemic. **Infection, disability, death.	Covid-19 virus, which spreads very rapidly, has been declared a pandemic by World Health Organization (WHO).	5	5	25	People over 65, individuals with chronic diseases, pregnant women, disabled individuals and employees who require special policies must be isolated (home office, leave, etc.)
6	General	Electrical Wiring	*Lack of insulating mat under the electrical panel / wetness under the panel. **Electric shock, serious injury, burn, death.	Required warning signs are not available.	5	5	25	Insulating mats must be placed under electrical panels in the enterprise. If wet floor cannot be dried, insulating mat must be positioned in a way to prevent contact of the insulating mat with water.
7	Electrical Panels	Electrical Wiring and Equipment	*Lack of leakage current relay **Electric shock, death.	Leakage current relay is defective.	5	5	25	Leakage current relays must be present at main boards (300Ma) and secondary boards (30Ma).
8	General	Not observing individual safe distance or close contact due to coronavirus pandemic, and lack of remote communication during meetings	*Exposure to coronavirus pandemic. **Infection, disability, death.	It has been detected that teleconference method is not used commonly for trainings and meetings.	4	5	20	Interviews and meetings must be conducted via remote communication.
9	Locker Rooms	Common Use Areas	*Employees becoming infected. **Spread of infection, disability, death.	It has been detected that there is no disinfection checklist in locker rooms.	4	5	20	Locker rooms must be disinfected periodically, and checklist must be marked.
10	Cafeteria	Common Use Areas	*Employees becoming infected. **Spread of infection, disability, death.	It has been detected that metal and glass materials are used in the cafeteria.	4	5	20	Cafeterias must switch to plastic tray and packaged fork, spoon, water and bread system. Water, jug and salad bars must be covered or distributed by cafeteria personnel ensuring that 1,5 m distance is preserved.

Table 6. (Continued)

No	Department	Hazard	*Probability / **Risk	Current Situation	P	S	R	S	Recommendations/Measures to be Taken
11	General	Machinery and equipment used in common	*Employees becoming infected. **Spread of infection, disability, death.	Covid-19 virus, which spreads very rapidly, has been declared a pandemic by WHO.	4	5	20		Machinery and equipment must be disinfested periodically.
12	General	Machinery	*Lack of instructions of use for machinery. **Serious injury, long-term treatment.	Machines lack instructions of use.	5	4	20		Machines without instructions must not be used and instructions must be prepared immediately
13	Shipping	Working at height	*Lack of guardrails on the side of ramps. **Falling from height, serious injury.	There are no guardrails on the sides of ramps despite the area is suitable for guardrail construction.	5	4	20		The area around the ramps that would cause falling from height must be covered 50 cm – 100 cm from the ground with guardrail protection.
14	Shipping	Moving vehicles and machinery (Shipping area)	*Lack of protective enclosures of ramp pistons. **Jamming of limbs, serious injury.	Ramp pistons do not have protective enclosures.	5	4	20		Ramp pistons must be supported with protective enclosures, and manual interventions of personnel must be prevented.
15	Empty Tube Storage Area	Explosion (Empty tube stock area)	*Doors being open, tubes being not fixes. **Explosion, serious injury, death.	Tubes are not fixed separately as empty-full.	4	5	20		Tubes in empty tube area must be fixed and its door must be kept locked.
16	Waste Area	Electricity (Fuse box)	*Lack of electric panel cover. **Electric shock, severe injury, burn, death.	Cover of electric panel is not mounted.	4	5	20		Fuse box cover must be mounted in order to ensure that it is not affected from possible weather conditions.
17	Roof	Working at height (Roof climbing area)	*Lack of lock at the stairs. **Falling from height, injury, death.	The stair has a lock mechanism but is not locked.	4	5	20		The stairs used to climb to the roof outside the factory must be locked in order to prevent it from being used by unauthorized personnel without safety measures.
18	General	Coronavirus pandemic, inappropriate conditions for hand hygiene	*Exposure to coronavirus pandemic. **Infection, disability, death.	It has been found that there is sufficient amount of liquid soap at toilets. It has been detected that alcohol-based disinfectants are not present in every area.	4	5	20		Attention must be paid to hand hygiene, hands must be washed with soap and water for at least 20 seconds, and hand sanitizers with 70-80% alcohol concentration must be used when there is no soap and water.
19	General	Social and individual behaviors due to coronavirus pandemic	*Exposure to coronavirus pandemic. **Infection, disability, death.	It has been found that social communication among employees is not appropriate for pandemic prevention rules.	4	5	20		Shaking hands and kissing must be prohibited; employees must avoid touching their mouths, noses and eyes with dirty hands; mouth and nose must be covered by single-use napkin when coughing and sneezing, and inside of the elbow must be used if there is no napkin to be used.
20	General	Lack of hygiene equipment among coronavirus measures	*Exposure to coronavirus pandemic. **Infection, disability, death.	Covid-19 virus, which spreads very rapidly, has been declared a pandemic by WHO.	4	5	20		All equipment requiring hygiene (glasses, towels, etc.) must be personal and not used in common. Manual washing must be avoided, and dishes must be washed in the dishwasher.
21	General	Emergencies (Explosion, fire, etc.)	*Emergency lights are insufficient. **Serious injury, long-term treatment.	Emergency lights are insufficient.	4	4	16		Emergency lights must be installed in locations with deficient lighting.
22	General	Fire	*Insufficient number of fire extinguishers. **Fire, serious injury.	There are no fire extinguishers in certain areas marked with signs.	4	4	16		Fire extinguishers in areas marked with signs must be completed.

Table 6. (Continued)

No	Department	Hazard	*Probability / **Risk	Current Situation	P	S	R	S	Recommendations/Measures to be Taken
23	General	Fire	*Smoke sensor systems not operating. **Fire, serious injury.	Some smoke sensors are defective.	4	4	16		Smoke sensor systems must be checked and replaced (if necessary) in periodic intervals.
24	General	Fire	*Fire alarm buttons not operating. **Fire, serious injury.	The fire alarm button in the storage department is not working.	4	4	16		Fire alarm buttons must be checked and made operational in periodic intervals.
25	General	Moving vehicles and machines	*Lack of iron guardrail in the front part of the pallet truck. **Serious injury, long-term treatment.	There is no iron guardrail in the front part of the pallet truck.	4	4	16		Appropriate guardrails must be installed on the front part of the pallet truck.
26	Shipping	Chemical substances	*Lack of MSDS forms of chemicals used. **Serious injury, burn, occupational disease.	There are no MSDS forms for chemical substances where they are stored.	4	4	16		MSDS data sheets of all chemical substances must be hang where the chemical substances are stored at.
27	Shipping	Chemical substances	*Insufficient ventilation. **Occupational disease.	Insufficient ventilation in serigraphy section.	4	4	16		Ventilation in serigraphy section must be reinforced according to standards.
28	C Line	Chemical substances suspended in the air	*Insufficient ventilation. **Occupational disease.	Ventilation is not sufficient in C line section.	4	4	16		Ventilation system in C line press section must be reinforced according to standards.
29	C Line	Faulty storage (Feeding point)	*Not using the apparatus to prevent falling of glasses. **Serious injury, long-term treatment due to falling of glasses.	Employees do not use the apparatus to prevent falling of glasses despite they are available.	4	4	16		Employees must be trained in terms of using the apparatus to prevent falling of glasses as well as providing required warnings/notices.
30	A Line	Moving vehicles and machines (piston in the corner turning point in line A)	*Not using protective enclosures of machinery and equipment. **Jamming of limbs, serious injury.	Protective enclosures of the machine are not used.	4	4	16		Awareness trainings must be provided to employees in order to prevent jamming of limbs of personnel in the movement area of the pistons.
31	New Panel Department	Moving vehicles and machines (Rinsing machine)	*Not using protective enclosures of machinery and equipment. **Serious injury, long-term treatment.	The machine does not have protective enclosures.	4	4	16		The new board rinsing line must be enclosed with fence to prevent possible accident risks.
32	Rohmer	Moving vehicles and machines (Rohmer machine)	*Not using protective enclosures of machinery and equipment. **Serious injury, long-term treatment.	The machine does not have protective enclosures.	4	4	16		Rohmer machine must be enclosed with fence to prevent unauthorized intervention.
33	Pressing Room	Chemical substances suspended in the air	*Insufficient ventilation. **Occupational disease.	Ventilation system is not sufficient.	4	4	16		Appropriate ventilation system must be installed in board press chamber.
34	General	Crash (Walkways inside the factory)	*Deformation on paints of walkways and forklift ways. **Serious injury, long-term treatment.	Paints of walkways and forklift ways are faded.	4	4	16		Walkways and forklift ways must be painted and made apparent.
35	Maintenance Department	Moving vehicles and machines (Spiral machine)	*Protective enclosure of the machinery equipment not being mounted. **Serious injury.	The machine has protective enclosures, but not mounted.	4	4	16		Protective enclosure must be mounted on the spiral machine, and machine equipment without protective enclosures must not be operated.
36	Production	Moving vehicles and machines	*Cutting tools and equipment left in the open. *Injury due to cuts.	Protective handles are available, but not mounted.	5	3	15		Use of cutting equipment without protective handles must be prevented, and the personnel must be informed.
37	A-B End-of-Line Pressing 2	Electricity	*Dripping of water from the discharge system of the air conditioner next to the electrical board. *Electric shock, serious injury, burn.	The water dripping from discharge hose of the air conditioner causes the insulating mats under the electric boards to lose their functions.	5	3	15		Discharge hose of the air conditioner must be checked to prevent leakage.

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