Volume: 1, Issue: 2, 2022, pp. 69-75
E - ISSN: 2822-5228
URL: https://journals.gen.tr/index.php/jgcc/index
DOI: 10.56768/jytp.1.2.04

Received: 09.11.2022
Accepted: 23.11.2022

ORIGINAL ARTICLE

An example of environmental risk assessment with L-type method: Cold storage in food industry

Selin Yardımcı Dogan[1] **Sezen Coskun**[2] **Mehmet Beyhan**[3]

1 Suleyman Demirel University, Department of Civil Engineering, Türkiye, e-mail: seln.yrdmc06@gmail.com
2 Egirdir Vocational School, Isparta University of Applied Sciences, Türkiye, e-mail: sezencoskun@isparta.edu.tr
3 Suleyman Demirel University, Department of Civil Engineering, Türkiye, e-mail: mehmetbeyhan@sdu.edu.tr

ABSTRACT

In this study, the environmental risk assessment for a cold storagefor food industry in the Mediterranean region was determined by the L matrix method. Waste amounts of the cold storage area and offices, possible environmental hazards have been identified. Environmental risks in wastewater, hazardous wastes, other solid wastes, and air pollution were analyzed for risk values. As a result, the activities with the highest environmental risk valueshave been identified as wastewater generation from fruit washing, mercury pollution that may occur due to fluorescent lamps from office and cold storage, contaminated packaging due to detergents to be used for cleaning in cold storage.

Keywords: Cold storage, environmental risk assessment, food industry, Lmatrix.

Citation: YARDIMCI DOGAN, S., COSKUN, S. & BEYHAN, M., An example of environmental risk assessment with L-type method: Cold storage in food industry. *Journal of Global Climate Change*. 2022; 1(2): 69-75, DOI: 10.56768/jytp.1.2.04

Corresponding Author:
Sezen Coşkun
Email: sezencoskun@isparta.edu.tr

1. INTRODUCTION

Cold storages play a very important role in terms of consumption of the products outside the harvest period and preserving their freshness. High energy consumption is required for cold weather facilities that allow the consumption of food throughout the year (Zheng et al., 2022). For this reason, energy saving, and environmental protection are of great importance for cold storage as well as for other sectors. There is a need to establish environmental management and quality management systems to ensure the sustainability of food use and to protect the environment (Marmiroli et al., 2022). However, businesses should evaluate the environmental risks and potentials at the project stage and implement management practices to minimize these risks (Jones,2001).

Hazard identification, risk assessment and management are of great importance for the safe and efficient production of the industrial system (Hao and Nie, 2022). Risk assessment is the science-based component of risk analysis, which consists of four basic steps (hazard identification, hazard characterization, exposure assessment and risk characterization) (Mahoney, 2022). Among the quantitative methods of risk analysis is the L-type matrix method. Since the L type matrix can be applied in all small and large enterprises and because it is an easy method, this method has made it the most applied risk analysis method in the occupational health and safety sector. L type matrix method can be applied even with a single analyst (Soykan, 2018). After the risk has occurred, together with the probability of its occurrence it is an evaluation tool used to analyze the effect it will create as a binary variable (Selcuk and Selim, 2018).

Environmental risk assessment is the process of identifying, evaluating, selecting, and implementing actions to reduce risks to human health and the ecosystem (Celik, 2000). In developed countries, studies such as emergency plans and data banks are carried out to assess environmental risks (Sunar, 1998).

As a result of developing quality management systems, the importance of environmental risk analysis studies has increased. Although there aren't many articles in the literature, a few case studies have been identified. Kuleyin and Asyali (2007), calculated the environmental risk analysis for Aliaga port using the L-type matrix method. A risk checklist of 5 items has been created and measures have been specified for 8 identified hazards (Kuleyin and Asyali, 2007). These hazards include storage and handling operations of cargoes (dry-liquid bulk cargo, general cargo, chemical), port cargo equipment, refueling operations, hazardous and non- hazardous wastes, maintenance operations in the building and port area, air pollution, noise, light, odor. and is formed during garbage. According to the research, legal obligations must be complied with and implemented in order to prevent hazards. Ciftci and Beyhan (2021), The environmental risk assessment of ready-mixed concrete plants in Denizli and Adana was carried out and compared with the L-type matrix method. The environmental risk of the ready-mixed concrete plant in Denizli is less, and it has been determined that all environmental risks in the plant can be reduced to a minimum with the implementation of the recommended measures. It has been observed that the unacceptable risks are higher in the ready mixed concrete plant in Adana (Ciftci and Beyhan, 2021). Falco et al. (2017), the environmental impact determined by the application of storage technology was evaluated using the LCA method. Input and output data are translated into environmental effects such as climate change, acidification, eutrophication and photochemical oxidation. It is expected to have positive effects on the environment, as it improves the energy efficiency of the air conditioning system and reduces electricity consumption (Falco et al., 2017).

Within the scope of this study, the environmental risk assessment of the selected food cold storage was made with the L-type matrix method and solutions were determined about the identified risks. Increasing environmental risk assessment studies will contribute to raising awareness of preventing environmental pollution while creating environmental protection policies and establishing quality management systems.

2. MATERIALS AND METHODS

Since the L matrix method can be applied in small and large enterprises, it is both an easy method and the most applied risk analysis method in the occupational health and safety sector (Selcuk and Selim, 2018).

The L matrix method, which is a two-dimensional matrix graph, has different meanings for horizontal and vertical coordinates.The horizontal coordinate shows the risk consequences (C), and the vertical coordinate shows the likelihood (L) of the risk (Wang and Wang, 2020).

In this method, the risk score is calculated for each environmental element. According to the result of the risk score, suggestions were made to the facility according to whether the risk is acceptable risk, significant risk, high risk and very serious risk (Gul et al., 2014). The risk score was calculated with the following formula and analyzed according to likelihood classification (MSANZ, 2004).

Risk (R) = Likelihood (L) x Consequences (C)

In this place;

L = Likelihood (1-5)

C = Consequences (1-5)

R = data and the result is the degree of risk (Table 1), for risk results are given in Table 2.

Where;

Likelihood:

1: Classification is named "So Light"; insignificant environmental impact, 2: Classification is named "Light"; minor operational rash, 3: Classification is named "Middle"; significant environmental damage, 4: Classification is named "Serious"; environmental life suffers serious losses, 5: Classification is named "So serious"; Disaster (MSANZ, 2004).

Consequences:

1: Classification is named "Very small"; hardly ever, 2: Classification is named "Small"; very little (once a year), only in abnormal situations, 3: Classification is named "Middle"; few (several times a year), 4: Classification is named "High"; often (monthly), 5: Classification is named "Very high"; Very often (once a week, every day) (MSANZ, 2004).

Table 1. Risk score (MSANZ, 2004)

Likelihood		5	4	3	2	1
		So serious	Serious	Middle	Light	So light
5	Very high	25	20	15	10	5
4	High	20	16	12	8	4
3	Middle	15	12	9	6	3
2	Small	10	8	6	4	2
1	Very small	5	4	3	2	1

Table 2. Risk results (MSANZ, 2004)

Risk score	**Action (activity)**	
15,16,20,25	Unacceptable	Action should be taken immediately to reduce risks.
8,9,10,12	Considerable risk	Risks should be addressed as quickly as possible.
1,2,3,4,5,6	Acceptable risk	Immediate action may not be required.

2.1. Facility Data

A food cold storage located in the Mediterranean Region was selected for the study. It operates in cold storage operations in the selected facility. There are 2 packing houses and 2 cold storages with a capacity of 20 thousand tons. 250 people work at the facility.

Wastes in the company are defined in 7 categories. These wastes; 16 06 04 waste code alkaline batteries, 20 01 21 waste code waste fluorescent lamps and mercury lamps, 15 01 01 waste code paper and cardboard packaging, 15 01 02 plastic packaging, 15 01 10 packaging containing residues of dangerous substances or contaminated with dangerous substances , absorbents, filter materials (oil filters, if not otherwise specified), cleaning cloths, protective clothing contaminated with hazardous materials with waste code 15 02 02, non-hazardous mixed municipal waste with waste code 20 03 01. Table 3 gives the waste amounts in 2021. These categories are determined in the Waste Management regulation published by the Ministry of Environment and Urbanization in Turkey (Anonymous, 2015).

3. RESULTS AND DISCUSSIONS

The environmental risk assessment of the selected company was made using the L-type matrix method. The cold storage environmental risk assessment is given in Table 3. There are 8 hazards in Table 4. The risk values of these hazards have been found and precautionary methods have been determined.

There is no environmental risk related to air emission and noise at the facility. Because there is no point and area emission source for air emission, there is no combustion boiler and chimney, it is not subject to the industrial air pollution control regulation. For noise, it is not within the scope of the environmental noise assessment and management regulation and is outside the scope of the environmental permit.

In Table 4, there are 8 environmental hazards identified for cold storage. No activity in the notable risk (R= 8, 9, 10, 12) class has been detected in the cold storage. Many activities inthe study area were evaluated in the unacceptable risk group (R= 15, 16, 20, 25). These hazards can be listed as battery operated devices, lamps and lamps used in lighting, contaminated packaging, cleaning cloths and protective clothing. Paper waste, non-hazardous mixed municipal waste and wastewater generation from the use of printers are included in the acceptable risk group (R= 1, 2, 3, 4, 5, 6). The risk scores on environmental risk analysis of rose oil production in some industrial plants and environmental risk assessment in ready-mixed concrete plants gave similar results with this research (Coskun et al., 2022; Ciftci and Beyhan, 2021). Cleaning detergents and lamps and bulbs used in lighting are evaluated in the unacceptable risk group (Coskun et al., 2022). Activities at the facility are divided into office work and cold storage. The danger is the use of printers and correspondence, and the risk is the damage to environmental resources due to heavy use of paper. Battery-operated devices are shown as a danger, as the risk of alkaline batteries getting into the soil and harming living things. Lamps and bulbs used in lighting are dangerous, and it is a risk that the mercury content of waste fluorescent lamps and mercury bulbs will mix with nature and harm living things.

Lamps and bulbs used in lighting are dangerous, and there is a risk that the mercury content of waste fluorescent lamps and mercury bulbs will mix with nature and harm living things. In order

Table 3. Waste codes of the selected company and waste amounts in 2021

Waste code	Definition	Amount of waste(kg/year)	Disposal / recycling method
16 06 04	Alkaline Batteries	0,5	**D5**
20 01 21	Waste Fluorescent Lamps and Mercury Bulbs	1	**R13**
15 01 01	Paper and Cardboard Packaging	5000	**R12**
15 01 02	Plastic Packaging	500	**R12**
15 01 10	Packages Containing Residues of Hazardous Substances or Contaminated with Hazardous Substances	50	**R12**
15 02 02	Absorbers Contaminated by Hazardous Substances, Filter Materials (oil filters unless otherwise specified), Cleaning Cloths, Protective Clothing	5	**R1**
20 03 01	Non-hazardous Mixed Municipal Waste	1000	-

Table 4. Cold storage environmental risk assessment

ACTIVITY	DANGER	RISK	LIKELIHOOD	CONSEQUENCES	RISK SCORE	PREVENTION
Office work	Printer usage and correspondence	Damage to environmental resources dueto heavy paperuse	5	1	5	Waste should be sent to licensed companies.
Office work	Battery powered devices	Mixing of alkaline batteries with thesoil and harmingliving things	1	15	15	Waste should be sent to licensed companies.
Office work	Lamps and bulbs used in lighting	The mercury content of waste fluorescent lamps and mercury lamps mixes with nature and harms living things.	1	20	20	Lighting should be turned off when not in use. Automatic lighting can be used. Waste should be sent to licensed companies.
Cold storage	Crates in which fruits are collected	The harm of plastic crates to nature	5	1	5	Plastic waste should be collected and sent to licensed companies.
Cold storage and office work	Cleaning detergents	Contaminated packaging harming nature	1	20	20	Contaminated packages should be collected and sent to licensed companies on a regular basis.
Cold storage and office work	Cleaning detergents	Cleaning cloths, protective clothing harming nature	1	20	20	Cleaning cloths and protective clothing should be collected and sent to licensed companies on a regular basis.
Cold storage and office work	Organic waste and other office Waste	The unused parts of fruits and other wastes harm nature	5	1	5	Waste should be sent to licensed companies.
Cold storage and office work	Washing fruits and using water in the office	Wastewater generation	5	5	25	It should be stored in a sealed septic tank and cleaned regularly.

to reduce the risk, the lamps must be collected safely and delivered to licensed hazardous waste collection companies. The number of scientific studies containing applicable results on the recycling of lamp parts following mercury removal from waste fluorescent lamps is increasing day by day (Coskun and Civelekoglu, 2014; Coskun and Civelekoglu, 2015; Gedik et al., 2020). For example, the use of fluorescent lamp glasses as a suitable filler in the asphalt binder layer instead of traditional crushed stone dust can provide advantages such as reducing the solid waste load, protecting the ecosystem, and reducing the costs of pavement construction (Gedik, 2021; Viana et al., 2022). Due to the increasing demand for natural and man-made resources, pressures are increasing for effective recovery and reuse of waste materials (waste wood, metal, plastic, glass) in many areas, benefiting from technological developments and engineering improvements (Sahin et al., 2021). Applications related to zero waste management have also developed following this process. The number of scientific studies on important practices such as the Zero Waste Park (Sahin et al., 2022) and increasing people's awareness of waste management is increasing (Coskun 2021; Coskun 2022).The source of danger is the crates in which the fruits are collected, and the risk that the plastic crates will damage the nature. Cleaning detergents, contaminated packaging harming nature, and cleaning cloths and protective clothing harming nature are shown as hazards. Organic wastes and other wastes in the office are hazards, and unused parts of the fruit and other wastes pose a risk to nature. Washing fruits and using water in the office are dangerous, and the formation of wastewater is determined as arisk.

4. CONCLUSIONS

In the research, the risks were evaluated by using the L-type matrix method of the cold storage operating in the food sector in order to reduce the damages to the environment. As a result of this evaluation, a total of 8 risks, 5 of which are unacceptable risks, were identified and control and precautionary activities were determined separately for theserisks.

Wastes because of heavy use of paper resulting from the use of printers and correspondence should be sent to licensed companies once a year. Waste alkaline batteries resulting from battery-operated devices should be sent to licensed companies every 6 months. For lamps and bulbs used in lighting, lighting should be turned off except for use, there may also be automatic lighting, and it should be sent to licensed companies every 6 months for wastes. The plastic wastes of the boxes where the fruits are collected should be sent to licensed companies once a year in order not to harm the environment. Packages, cleaning cloths and protective clothing contaminated by cleaning detergents should be collected regularly and sent to licensed companies every 6 months. Organic and other office waste should be stored regularly and sent to licensed companies. Finally, the water caused by washing the fruits and using water in the office should be collected in an impermeable septic tank and cleaned regularly or sent to a wastewater treatmentplant.

REFERENCES

ANONYMOUS (2015). Date of Access: 06.09.2022.https://www.resmigazete.gov.tr/eskiler/2015/04/20150402-2.htm

CELIK, G. (2000). Ecological risk assessment in environmental management and problem formulation for Uluabat Ramsar Area. Uludag University, *Institute of Science and Technology*, 134s, Bursa.

CIFTCI, B., BEYHAN, M. (2021). Environmental risk assessment in ready-mixed concrete plants. *Bilge International Journal of Science and Technology Research*, 5(1), 13-21.

COSKUN, S. (2021). Effect of the Covid-19 pandemic period on zero waste awareness: A scale development survey in Turkey. *Global Nest Journal*, 23 (4), 581-589.

COSKUN, S., DOGAN, S. Y., BEYHAN, M. (2022). Environmental risk assessment of rose oil production. *In Recent Researches and Practices in Engineering Sciences,* 107-119.

COSKUN, S. (2022). Zero waste management behavior: Conceptualization, scale development and validation – A case study in Turkey. *Sustainability*, 14 (19), 12654.

COSKUN, S., CIVELEKOGLU, G. (2014). Characterization of waste fluorescent lamps to

investigate their potential recovery in Turkey. *International Journal of Global Warming*, 6(2/3), 140-148.

COSKUN, S., CIVELEKOGLU, G. (2015). Recovery of mercury from spent fluorescent lamps via oxidative leaching and cementation. *Water, Air and Soil Pollution*, 226 (6), 1-13.

FALCO, D. M., CAPOCELLI, M., LOSITO, G., PIEMONTE, V. (2017). LCA perspective to assess the environmental impact of a novel PCM based cold storage unit for the civil air conditioning. *Journal of Cleaner Production*, 165 (1), 697-704.

GEDIK, A., SELCUK, S., LAV, A. H. (2020). Investigation of recycled fluorescent lamps waste as mineral filler in highway construction: a case of asphaltic pavement layers. *Resources Conservation and Recycling*,168,105290.

GEDIK, A. (2021). An exploration into the utilization of recycled waste glass as a surrogate powder to crushed stone dust in asphalt pavement construction. *Construction and Building Materials*, 300, 123980.

GUL, M., GUNERI, A. F., SELVI, A. E. (2014). Matrix (L-Matrix) method-based risk assessment using fuzzy decision making approaches. *VII. International Conference on Occupational Health and Safety*, 7p.

HAO, M., NIE, Y. (2022).Hazard identification, risk assessmentand management of industrial system: process safety in mining industry. *Safety Science*, 154, 105863.

JONES, R. N. (2001).An environmental risk assessment/ management framework for climate change impact assessments.*Natural Hazards*, 23, 197-230.

KASPERSON, J. X., KASPERSON, R. E. (2001). Global environmental risk. 592s, London.

KULEYIN, B., ASYALI, E. (2007). Ship based environmental risk assessment and management in ports: Aliagaport application. Dokuz Eylul University, *Journal of Social Sciences Institute*, 9(1), 243-261.

MAHONEY, D. (2022). Safety and risk mitigation risk assessment in dairy processing -importance of food safety in the dairy processing sector. *Encyclopedia of Dairy Sciences*, 776-784.

MARMIROLI, M., CALDARA, M., PANTALONE, S., MALCEVSCHI, A., MAESTRI, E., KELLER, A. A., MARMIROLI, N. (2022). Building a risk matrix for the safety assessment of wood derived biochars. *Science of the Total Environment*, 839, 156265.

MSANZ (Maritime Safety Authority of New Zealand) (2004). Guidelines for port &harbour risk assessment and safety management systems, 68s, New Zealand.

OZTEKIN, A. (2010). Environmental risk assessment in lng road transport. Istanbul Technical University, Institute of Science and Technology. Master Thesis, 185s, Istanbul.

SAHIN, C., ONAY, B., MIRZA, E. A. (2021). A natural sustainable material for urban design: wood, In: Theories, Techniques, Strategies For Spatial Planners & Designers, Murat Ozyavuz (ed.), Peter Lang-Belirn, 221-233.

SAHIN C. K., SOLAK, E. B., SAVA, B., ONAY, B. (2022). A Case Study of Egirdir Zero Waste Park for Living and Learning. *European Journal of Applied Sciences*, 10(4), 591-603.

SELCUK, S., SELIM, H. H. (2018). L-Type Matrix method, one of the occupational health and safety risk analysis methods used in the jewelery industry. Istanbul Commerce University, *Journal of Technology and Applied Sciences*, 1(1), 21-27.

SOYKAN, O. (2018). Risk assessment in industry fishing vessels by L type matrix method and its usability. *Ege Journal of Fisheries and Aquatic Sciences*, 35(2), 207-217.

SUNAR, T. (1998). Environmental risk assessment of hazardous substances. Istanbul Technical University, Institute of Science and Technology. Master Thesis, 213s, Istanbul.

ZHENG, H., TIAN, G., ZHAO, Y., JIN, C., JU, F., WANG, C. (2022). Experimental study of R290 replacement R134a in cold storage airconditioning system. *Case Studies in Thermal Engineering*, 36, 102203.

WIANA, L. N., SARES, A. P. S., GUIMARAES, D. L., ROJANO, W. J. S., SAINT'PIERRE, T. D. (2022). Fluorescent lamps: A review on environmental concerns and current recycling perspectives highlighting Hg and rare earth elements. *Journal of Environmental Chemical Engineering.* 108915.

WANG, R., WANG, J. (2020). Risk analysis of out-drum mixing cement solidification by HAZOP and risk matrix. *Annals of Nuclear Energy*, 147, 107679.