FIRE SAFETY THREAT RISK ANALYSIS FOR SOFT TARGET

Adam Malatinsky, Irena Drofova,
Lucie Sousedikova & Martin Hromada

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Abstract

The level of threat risk within soft targets is constantly increasing during the development of the company. It is, therefore, necessary to pay more attention to this issue. This article deals with a qualitative risk analysis of soft target threats. When determining the level of risk, it is essential to characterize soft targets and their types. Qualitative risk analysis of soft targets threats compares and evaluates their interrelationship. Based on this correlation, it is essential to develop criteria through which the importance and significance of threat risks can be determined within the framework of soft targets. In addition to the established and evaluated analysis, it is also essential to develop proposals for measures to minimize the effects of potential threats under soft targets. The threats relate mainly to fire safety. A specific type of soft target for this threat risk analysis is a shopping centre.

Keywords: Soft target; Threat risk analysis; Fire safety; Safety

1. Introduction

Safety as a category is found in all sectors of society. One of the oldest categories concerns fire safeties. The article deals with fire safety in connection with a soft target. The need for safety and protection for soft targets is constantly increasing in the field of fire protection. Therefore, it is essential to respond promptly to the development of society and address the issue through various proposals, ideas, possible uses and their application. The first part after the introduction describes the soft goal, its degree of assessment, the primary type and its attractiveness. The following section describes the analysis, which identifies the most significant threats related to fire protection for a soft target - a shopping centre. The next part of the article focuses on assessing the significance of threats according to the established procedure. The following chapter shows the evaluated threats explicitly according to their significance for primary, secondary and tertiary. The last chapter of the article proposes measures for individual threats. Specifically, these are proposals for primary and secondary threats, as they pose a greater risk. The motivation for creating a threat risk analysis for a soft target in fire protection is to increase the protection of the population during shopping and minimize the impact of threats in the future.

2. Soft target

A soft target is an object, space, or action that is characterized by the presence of a large number of people and, at the same time, the absence or low level of security against attacks. The degree of threat to a soft target is assessed by type, specification, the density of people presents, public access, locality, security level, availability of means to attack, the occurrence of a given type of attack, the complexity of implementation of a given type of attack, impacts on lives and health impacts and impacts on the functioning of the affected community. The basic types of soft targets include transport, religious places, hospitals, nightclubs, restaurants, shops and shopping centres, government buildings, social and cultural events, sports events, schools and school facilities, tourist centres, streets, pedestrian zones, squares and places with immigrants present. The different types of soft targets are different from each other but have a common characteristic that makes them attractive to potential attackers. Common characteristics include openness to the public, presence of security personnel, number and concentration of persons, police presence, media attention and symbolism of the target. [2], [4]

3. Description of the analysis

It is appropriate to use qualitative risk analysis to evaluate the most significant risks in fire protection. Specifically, it is a qualitative analysis of competing risks. This method needs to follow the correct procedure in the following steps:

- Processing of risk inventory
- Compilation and completion of a correlation table of risks
- Creating the sum of risk correlations and calculating the coefficients of activity and passivity of individual risks
- Graphical risk assessment
- Calculation of axes of activity coefficients and passivity of individual risks
- Segment evaluation [1]

The individual segments determine how significant are the risks of the given threats for the specified object.

4. Analysis procedure

Based on the individual steps in the previous chapter, the given method is applied.

4.1 *Processing of risk inventory*

Risk inventory means determining the most common and most likely possible threats that may occur in a given building [3]. As part of the fire protection for the shopping centre building, the following threats are identified:

- Fire
- Smoke
- Flooding
- Explosion
- Leakage of hazardous substances
- High temperature in the building
- Escape exit blocking
- Disorientation
- Failure of the fire protection system and its components
- Undefined assembly point
- Untrained staff
- Absence of fire extinguishers
- Power outage

4.2 *Compilation and completion of a correlation table of risks*

Based on the individual risks of a threat in the shopping centre within the fire protection framework, a table of correlation of risks will be created, which expresses the interrelationships between the identified risks. The table will contain individual threats arranged vertically and horizontally. For the specific situation for the shopping centre, the 13 most significant threats that can occur will be used. A threat table is created in which the following three values are expressed:

x – this letter means that it cannot pose a risk of itself

1 – expresses the real possibility that the risk may give rise to another risk

0 – expresses a state where a given risk cannot give rise to another risk

Number	Threat	1	2	3	4	5	6	7	8	9	10	11	12	13
1	Fire	x	1	0	1	1	1	1	1	0	0	0	0	1
2	Smoke	0	x	0	0	0	0	0	1	0	0	0	0	0
3	Flooding	0	0	x	1	1	0	1	1	1	0	0	0	1
4	Explosion	1	1	0	x	1	1	1	1	1	0	0	0	1
5	Leakage of hazardous substances	1	1	0	1	x	1	1	1	1	0	0	0	1
6	High temperature in the building	1	1	0	1	1	x	0	0	0	0	0	0	1
7	Escape exit blocking	0	0	0	0	0	0	x	1	0	0	0	0	0
8	Disorientation	0	0	0	0	0	0	0	x	0	0	0	0	0
9	Failure of the fire protection system and its components	0	0	0	0	0	0	0	0	x	0	0	1	0
10	Undefined assembly point	0	0	0	0	0	0	0	1	0	x	0	0	0
11	Untrained staff	1	0	0	1	1	0	1	0	1	1	x	1	0
12	Absence of fire extinguishers	0	0	0	0	0	0	0	0	0	0	0	x	0
13	Power outage	0	0	0	0	0	0	0	1	1	0	0	0	x

Table 1. Interrelationships between threats

4.3 Creating the sum of risk correlations and calculating the coefficients of activity and passivity of individual risks

In this section, two coefficients are expressed: an activity coefficient, which expresses the total potential risk of causing additional threat risks, and a passivity coefficient, which expresses the number of all risks that a given risk may cause. The following equations are used to calculate the coefficients:

$$K_A R_i = \frac{\sum R_i}{x - 1} \quad (1)$$

$$K_P R_i = \frac{\sum R_i}{x - 1} \quad (2)$$

Where:

$K_A R_i$ – activity coefficient

$K_P R_i$ – passivity coefficient

$\sum R_i$ – the sum of risks (for the activity coefficient it is the horizontal axis and vertical axis for passivity coefficient

x – total number of threats [1]

After calculating the given coefficients for all threat risks, the resulting stocks are multiplied by the number 100 to the percentage.

Number	Threat	Activity coefficient [%]	Passivity coefficient [%]
1	Fire	58	33
2	Smoke	8	33
3	Flooding	50	0
4	Explosion	67	42
5	Leakage of hazardous substances	67	42
6	High temperature in the building	42	25
7	Escape exit blocking	8	42
8	Disorientation	0	67
9	Failure of the fire protection system and its components	8	42
10	Undefined assembly point	8	8
11	Untrained staff	58	0
12	Absence of fire extinguishers	0	17
13	Power outage	17	42

Table 2. Determination of activity and passivity coefficients

4.4 Graphical risk assessment

Based on Table 2, the values of the coefficients of individual threats are recorded in a graph, where the values of the coefficient of activity are located on the horizontal axis, and the values of the passivity coefficient are located on the vertical axis.

Graph 1. Threats according to the reciprocity of the activity and passivity coefficients

4.5 Calculation of axes of activity coefficients and passivity of individual risks

To determine the significance of threat risks, it is necessary to divide Chart 1 into four segments. To divide the graph, we will need two lines (horizontal and vertical), which will divide the graph into four parts. The first segment is expected to account for 80% of these most significant risks. The following mathematical relationships are used to calculate the axes.

$$S_1 = K_{Amax} - \frac{(K_{Amax} - K_{Amin})}{100} * 80 = 67 - \frac{(67 - 8)}{100} * 80 = 19,8 \quad (3)$$

$$S_2 = K_{Pmax} - \frac{(K_{Pmax} - K_{Pmin})}{100} * 80 = 58 - \frac{(58 - 8)}{100} * 80 = 18 \quad (4)$$

Where:

S_1 – vertical axis for activity coefficient

S_2 – horizontal axis for passivity coefficient

K_{Amax} – maximum value within the activity coefficients

K_{Amin} – minimum value within the activity coefficients;

K_{Pmax} – maximum value within the passivity coefficients

K_{Pmin} – minimum value within the passivity coefficients

For greater accuracy, values outside the value of 0 are calculated. [1]

4.6 Segment evaluation

The resulting values of the lines are plotted in the graph, and the graph is divided into four segments. According to these segments, it is possible to determine which group of significance the given threats belong to. The individual segments are:

- Segment I – primarily significant threats – high value of coefficient of activity and passivity
- Segment II and III – secondary significant threats – high value coefficient of activity or passivity
- Segment IV – tertiary significant threats – low value coefficient of activity and passivity [1]

Graph 2. Division of threats into four segments

5. Threat risk assessment

Based on Graph 2, it is possible to determine the significance of the threat risk for the shopping centre within the fire protection framework.

Significance of the threat	Threat number	Threat
Primarily	1	Fire
	4	Explosion
	5	Leakage of hazardous substances
	6	High temperature in the building
Secondary	2	Smoke
	3	Flooding
	7	Escape exit blocking
	8	Disorientation
	9	Failure of the fire protection system and its components
	11	Untrained staff
	13	Power outage
Tertiary	10	Undefined assembly point
	12	Absence of fire extinguishers

Table 3. Threats division by significance

6. Proposal measures

This part of the article focuses on designing measures for the most significant threats identified according to the qualitative analysis of the concurrence of risks listed in Table 3. The design measures are intended for primary and secondary threats, according to Table 3.

6.1 Fire

For the threat of fire, it is proposed to cover the shopping centre space with elements of a fire safety system with more frequent and regular inspection of their functionality by security staff, fire protection technicians, private security staff or responsible employees in the shopping centre. Another proposed measure is fire extinguishers to operations where there is a higher chance of fire. Typical facilities with a higher chance in the shopping centre include facilities providing services, entertainment, cinemas and electronics stores. Another proposal is to create a fire patrol with at least three members, who would be located directly in the shopping centre and the event of a fire, to minimise the fire's impact in the presence of a fire protection unit. It would also be advisable to place fire curtains to prevent the spread of fire. [5]

6.2 Explosion

For the threat of explosion, it is proposed to measure the temperature in the shopping centre, especially where there is a higher chance of elevated temperature. In explosion prevention, it is ideal for carrying out a practice evacuation to a safe assembly point at least once a year. Temperature measurement is near critical objects that could cause an explosion.

6.3 Leakage of hazardous substances

If there is a risk of leakage of a dangerous substance, it is advisable to use a device for measuring the concentration of the presence of a dangerous substance in the room. Ideally, this measurement would be performed by a fire protection technician or a responsible member of the fire brigade located directly in the shopping centre.

6.4 High temperature in the building

Due to the threat of increased temperature in the building, it is ideal for reducing the increased temperature in the premises to the ideal state by opening the windows, turning on the air conditioning or cooling the outdoor areas with water. [6]

6.5 Smoke

For the threat of smoke, it is advisable to apply devices for smoke extraction and fresh air supply. Another preventive measure in case of the threat of smoke is the use of virtual reality in which the space of the shopping centre would be virtually created, and a member of the fire brigade could better orient himself in the space in case of the real presence of smoke. [7]

6.6 Flooding

Due to the threat of flooding, it is advisable to evacuate all persons present to a safe place outside the areas affected by the flood. It is ideal for creating pumps in the building to drain the water in the building to the nearest river or stream located near the shopping centre.

6.7 Escape exit blocking

For the threat of blocking the escape exit, it is ideal for checking the functionality of the escape exit regularly with a fire patrol unit every day before opening the shopping centre to the public. [8]

6.8 Disorientation

For the threat of disorientation of persons, it is ideal to create a sufficient number of information signs with the location of individual operations and with an escape exit.

6.9 Failure of the fire protection system and its components

For the threat of failure of the fire protection system and its element, it is ideal for checking the correctness of the fire control panel at least twice a day and to check the correctness of the elements at least once a week by members of the fire brigade or fire protection technician. In the event of a fault, it is essential to contact the service immediately.

6.10 Untrained staff

Due to the threat of untrained personnel in fire protection, it is ideal for training every new employee before starting work and regular training on occupational safety at least once a year.

6.11 Power outage

For the threat of a power outage, it is advisable for the shopping centre to procure a unit that would at least manage the fire protection system and its elements in the event of a threat.

7. Conclusion

Fire safety is one of the oldest types of safety in the development of the company. The article dealt with analysing the risk of threats to the soft target shopping centre under fire protection. In the beginning, the article described the definition of a soft target, its types, the degree of assessment and attractiveness.

The next chapter described the analysis used to evaluate the significance of threat risks for a given object type. Specifically, it is a qualitative analysis of the correlation of risks. The next chapter dealt with a specific procedure for assessing the significance of threats based on this chapter. First, a list of threats was created, based on which a table of risk correlations was created, which assessed whether the individual risks were related to each other. Two coefficients were created from the given data: the activity coefficient and the passivity coefficient, which were graphically recorded in the graph. To determine the significance of threats, it was essential to create four segments to identify them. To divide the graph into segments, it was necessary to calculate lines: horizontal and vertical, which divided the graph, where threats belonging to the first segment meant significant primary threats, to the second and third segments meant secondary threats and threats falling into the fourth segment represented tertiary (less significant threats). Based on these data, a table was created in the next chapter, where the individual threats were sorted according to their significance, where the significant primary threats include: fire, explosion, leakage of a dangerous substance and elevated temperature in the building. Secondary significant threats include smoke, flooding, escape route blocking, disorientation, fire protection system failure and its components, untrained personnel, and power outage. Tertiary significant threats include unspecified assembly points and the absence of a fire extinguisher. The last part of the article proposed design measures for primary and secondary significant threats, as they pose a greater threat risk than tertiary threats. These proposed measures are the subjective opinion of the author of the article. This process of creating a qualitative analysis to determine the risk of threats was created based on the ever-increasing risk of soft targets in fire protection. Therefore, it is essential to constantly update these risk probabilities with the development of society to identify new and primary threats. The plan to identify soft target threats in the future is to create and update new major threats as often as possible. Based on current threats, it is also essential to create and apply measures to minimise potential threats to soft targets to increase society's security continuously.

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