DETERMINATION OF THE SAFETY SITUATION WITHIN THE FIRE PROTECTION

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Abstract

The article deals with determining the safety situation of the given environment within the framework of fire protection. The first chapter describes, in general, the safety situation within fire safety. The next part proposes the creation of two safety models within fire protection. The following chapters deal with the degree of danger and the proposed fire risk. Based on the knowledge from these parts, the whole follows regarding the determination of the safety situation's final state within the fire protection. The last part of the article assesses the security situation on a specific example.

Key words
Fire Safety, Safety Situation, Safety Model, Degree of Danger, Fire Risk.

Introduction

Security expresses the sense of need necessary for the existence of society. Fire safety is one of the oldest types of safety, continually transforming with society's development. For an appropriate evaluation of the overall final state, it is necessary to characterize the security situation. There are proposed two models for assessing the safety situation in fire protection to assess the safety situation. In this context, it is a preventive-repressive model and a repressive model. Within the proposed preventive-repressive model, the resulting state of the given environment's safety situation is subsequently applied to the context of fire protection.

1 Safety situation

The safety situation is the current state, which expresses the degree of threat to the reference object and its assets. It is usually evaluated to investigate the possibility of a security breach. It can also be defined as a property of the safety environment at a particular time or period. [1]

The safety situation can be expressed in perspective from two main points of view - static or dynamic. A static description of a security situation expresses the conditions set for someone or something at a particular set time in space. It is a longer-term expression of the security situation. A dynamic description of a security situation expresses the behaviour and interaction of ties in a particular situation. It can also be characterized as a sequence of successive events or phenomena. It expresses the immediate security situation. [2] [3]

2 Safety situation model

The model expresses a way of describing a real situation oriented towards a possible security breach. This characteristic and representation can also be realized graphically, on a map, quantitatively, qualitatively, by information support or in other ways. Within safety

models, the following basic types are distinguished: preventive, proactive, repressive and their combinations. Within this article, two types of security environment models are described. Specifically, it is a preventive-repressive and repressive model.

The preventive-repressive model is primarily intended for prevention, with which it closely follows repression. The model is defined in two variants: basic and extended. The basic model defines two primary components: the degree of danger and the fire risk. The degree of danger and fire risk are described in the next part of the article. Both components have equal weight in expressing the safety situation. The extended preventive-repressive model of the security situation divides the primary component of fire risk into four separate components: fire, flood activity, technical interventions and distance. The division of fire risk is divided into these four components because they are the most common ways of compromising fire protection safety. In the case of an intervention by a fire brigade that is not directly related to the fire or flood activity, this type may include it in the set of technical interventions.

Fig. 1
Basic model [source: author]

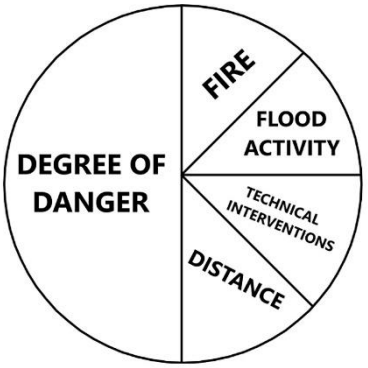

Fig. 2
Extended model [source: author]

When evaluating the safety situation, the degree of danger is considered, which has the same weight in the evaluation as all these four separate units. This means that the degree of danger is 50 % during the evaluation, and the fire risk is 50%. Furthermore, since the fire risk consists of 4 separate units, equal division of 1 separate unit from the fire risk has a value of 12.5%.

The repressive model is primarily intended for the repression and response of fire protection components after an emergency. The repressive model is also defined in 2 variants: basic and extended. The basic model defines two essential components: primary and secondary data. Primary data are those that are primarily intended for units performing repressive activities. Secondary information is that which is provided to the rescue services after the primary information. This is information that can only be taken into account in the second step for repression performance (for example, only after leaving the fire station). The extended repressive model divides primary and secondary information into several parts. The primary information is divided into two separate parts: the difficulty of the intervention, which is quantified from 1 to 5, where 5 is the highest difficult of the intervention, and a part called the type of intervention, which determines the type of intervention (e.g., fire, traffic accident, floods, evacuation, etc.) Secondary information is divided into three separate parts: the distance between the place of the emergency and the fire station. Another part is the presence of voluntary fire protection expressing the presence of voluntary fire protection members who could help carry out repressive activities in the event of an emergency. The last part is the

coordination, which is essential when interoperability of several components of the integrated rescue system at the scene of an emergency is needed.

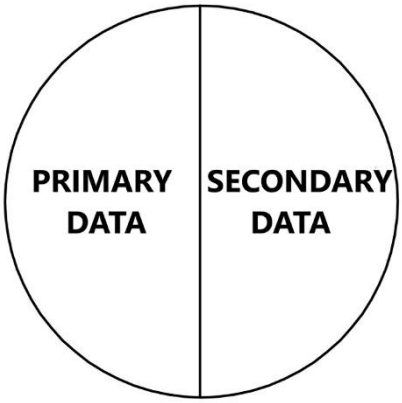

Fig. 3
Basic model [source: author]

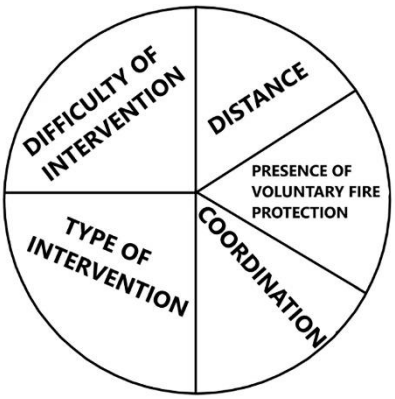

Fig. 4
Extended model [source: author]

The evaluation of the resulting security situation based on an extended repressive model is based on the individual weights of the resulting values: difficulty of intervention - 25%, type of intervention - 25%, distance - 16.7%, presence of voluntary fire protection - 16.7%, coordination - 16.6 %.

The application and evaluation of the security situation in the given area are based on this article on the extended preventive-repressive model of the security situation in the context of fire protection.

3 Degree of danger

The determination of the degree of danger is based on Decree no. 611/2006 Coll. Ministry of the Interior of the Slovak Republic on fire brigades of a given degree of danger for a given territory. The entire method of evaluation is specified in this decree. In this context, it is necessary to formulate a restriction of the article, where for better clarity, only specific data specific to a given territory are evaluated. To determine the degree of danger, the following three categories are used: the criterion of the number of inhabitants, the criterion of the evaluation of the cadastral area, the criterion of the number of trips to interventions. The criterion of the population is determined by the number of inhabitants in a given area. The criterion of evaluation of the municipality's cadastral territory is expressed according to whether there are recreational areas, residential houses, shopping centres, industrial zones, accident sites, etc. in the given area. The criterion of trips to interventions expresses the number of trips per year or the average for five years. The total criterion is determined by the sum of all three previous criteria. Based on the sum of points from individual criteria, the total point value is evaluated, determining the degree of danger. The number of danger levels under this decree is 7. [4] [5] [6]

4 Fire risk

The newly proposed fire risk is part of the preventive-repressive model of the security situation within the fire protection framework and has half the value in evaluating the overall final state of the security situation. According to the extended preventive-repressive model of the safety situation within the fire protection framework, the fire risk is divided into four equally basic units: fire risk, flood activity, technical interventions and distance.

Fire expresses the activities of firefighters directly related to the fire. In evaluating the safety situation within the area fire, it is proposed to set a scale ranked from 1 to 7. Values 1 to 7 are expressed based on statistics on the number of fires in the area (usually last year or average for the last five years) – Tab. 1.

Flood activity expresses firefighters' activities related to water removal, long-distance water transport, flood prevention measures, etc. In evaluating the safety situation within the flood activity of the area, it is proposed to set a scale ranked from 1 to 7. Values 1 to 7 are expressed based on statistics on the number of floods in a given usually last year or average for the last five years) – Tab. 2.

Table 1
Determination of fire value

Fire value	Number of fires per period
1	0 – 1
2	2 – 3
3	4 – 5
4	6 – 7
5	8 – 9
6	10 – 12
7	over 12

[source: author]

Table 2
Determination of the value of flood activity

Value of flood activity	Number of flood activity per period
1	0 – 1
2	2 – 3
3	4 – 5
4	6 – 7
5	8 – 9
6	10 – 12
7	over 12

[source: author]

Technical interventions express the activities of firefighters related to various activities not covered by fire or flood activity. The most common include removing trees, disposal of objects, evacuation of people, traffic accident, the rescue of people from heights or depths, etc. In evaluating the safety situation within the technical interventions of the territory, it is proposed to set a scale ranked from 1 to 7. Values 1 to 7 are expressed based on statistics on the number of technical interventions in a given usually last year or average for the last five years) – Tab. 3.

The distance expresses the space between the place of the emergency and the seat of the fire station. It is also proposed to set a scale with values from 1 to 7 according to the distance in kilometres – Tab. 4.

Table 3
Determination the value of technical interventions

Value of technical interventions	Number of technical interventions per period
1	0 – 4
2	5 – 8
3	9 – 12
4	13 – 16
5	17 – 20
6	21 – 24
7	over 24

[source: author]

Table 4
Determination of the distance value

Distance value	Number of kilometres
1	0 – 3
2	4 – 6
3	7 – 9
4	10 – 12
5	13 – 15
6	16 – 18
7	over 18

[source: author]

Based on these four values, the overall degree of fire risk is determined. The resulting value is obtained as the arithmetic mean of the resulting values from the given four factors. If the resulting value is a decimal number, mathematical rounding occurs. The resulting overall determination of the degree of fire risk will have a value from 1 to 7. All four categories of fire risk have a proposed 7-level classification. This proposal is because of the number of degrees of danger according to Decree no. 611/2006 Coll. Ministry of the Interior of the Slovak Republic on fire brigades of a given degree of danger for a given territory it also has a 7-level classification, and both criteria (degree of danger and fire risk) have the same evaluation weight when determining the final state.

5 Determination of the final state

The resulting state of the fire risk's safety situation shall be expressed as the arithmetic mean of the resulting degree of danger and the resulting degree of fire risk. In the case of a decimal number, mathematical rounding occurs. The values of the final state of the safety situation within the framework of fire protection are expressed quantitatively (by number) or qualitatively (by description):

- 1 – **excellent** safety situation,
- 2 – **very good** safety situation,
- 3 – **good** safety situation,
- 4 – **manageable** safety situation,
- 5 – **relatively manageable** safety situation,
- 6 – **risky** safety situation,
- 7 – **very risky** safety situation.

In the following table, based on the resulting states of the safety situation within the fire protection, they belong to the individual resulting states of the safety situation, the proposed probability of the threat. This division is based on an expert estimate of the author.

Table 5
The probability of the threat of the resulting conditions

Final state		The probability of the threat (%)
Quantitative description	**Qualitative description**	
1	excellent	under 10
2	very good	10 – 20
3	good	21 – 35
4	manageable	36 – 50
5	relatively manageable	51 – 65
6	risky	66 – 80
7	very risky	over 80

[source: author]

6 Applying the safety model to a specific territory

The Skalica district area is selected for applying the safety model on a specific example. Skalica district is located in the Slovak Republic in the Trnava region. The district's total area is 357.1 km^2 and the total population is 47,064 inhabitants (of 31 August 2020). The population density is 132 inhabitants / km^2. There are 3 towns and 18 municipalities in the district. As part of fire protection, there are 1 Fire and Rescue Corps in the town of Holíč, 22 voluntary fire brigades, of which 2 are a company fire brigades. There is a voluntary fire brigade in each village, except for the villages of Kátov and Trnovec. In the town of Skalica there are 3 voluntary fire brigades, of which 2 are a company fire brigades. The following table sets out the degree of danger, the proposed fire risk and the total resulting state for individual municipalities and towns in the Skalica district. [7] [9] [10]

Table 6
Calculation of the degree of danger, fire risk and final condition

Village/town	Degree of danger					Fire risk					Final condition
	Cp	**Ca**	**Ci**	**Ct**	**RDD**	**NFI**	**NFA**	**NTI**	**DIS**	**RFR**	
Brodské	12	4	2	18	**3**	2	3	3	2	**3**	**3**
Dubovce	3	1	1	5	**1**	1	2	2	3	**2**	**2**
Gbely	21	7	3	31	**4**	3	2	3	5	**3**	**4**
Holíč	24	9	4	37	**4**	4	3	4	1	**3**	**4**
Chropov	3	1	1	5	**1**	1	2	2	5	**3**	**2**
Kátov	3	2	1	6	**1**	1	3	1	1	**2**	**2**
Kopčany	12	4	2	18	**3**	2	2	2	2	**2**	**3**
Koválovec	3	1	1	5	**1**	1	1	2	5	**2**	**2**
Letničie	3	1	1	5	**1**	1	2	2	4	**2**	**2**
Lopašov	3	2	1	6	**1**	1	1	2	5	**2**	**2**
Mokrý Háj	3	2	1	6	**1**	1	3	2	4	**3**	**2**
Oreské	3	2	1	6	**1**	1	3	1	5	**3**	**2**
Petrova Ves	6	3	1	10	**2**	2	2	2	4	**3**	**3**
Popudinské Močidľany	3	2	1	6	**1**	2	3	2	2	**2**	**2**

Continuation of table 6

Prietržka	3	2	1	6	**1**	1	2	1	2	**2**	**2**
Radimov	3	1	1	5	**1**	2	2	2	3	**2**	**2**
Radošovce	9	4	2	15	**3**	3	2	3	4	**3**	**3**
Skalica	27	15	5	47	**4**	5	4	6	3	**5**	**5**
Trnovec	3	2	1	6	**1**	1	1	2	1	**1**	**1**
Unín	6	3	1	10	**2**	2	2	3	4	**3**	**3**
Vrádište	3	3	1	7	**1**	2	2	2	2	**2**	**2**

[source: author]

*Where: **Cp** – population criterion, **Ca** – cadastral area evaluation criterion, **Ci** – criterion of the number of interventions, **Ct** – total criterion, **RDD** – the resulting degree of danger, **NFI** – number of fires, **NFA** – number of flood activity, **NTI** – number of technical interventions, **DIS** – distance, **RFR –** the resulting fire risk.*

7 Evaluation of the safety situation of a specific area

From the total final state of the security situation of the area within fire protection, it is clear that only one municipality belongs to the category of excellent safety situation (dark green colour), 12 municipalities belong to a very good safety situation (pale green colour), five municipalities belong to a good security situation (yellow colour), two cities belong to the manageable safety situation (orange colour), and one city belongs to the relatively manageable safety situation (red colour).

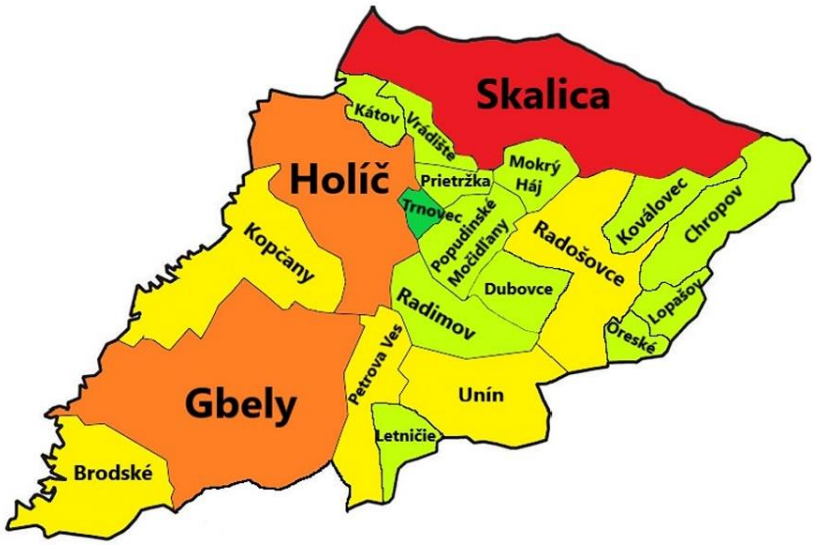

Fig. 5
Map of the Skalica district with the final state of the municipalities [8, modified]

When determining the district's overall security situation, it is essential to create an average value from the individual security situations of all municipalities and cities. It is based not only on the arithmetic average but also on the number of inhabitants and area.

The entire final state of the safety situation within the fire protection for the whole district of Skalica is **3 - good safety condition**. It follows that the expected probability of a threat that may cause harm to the reference object and its assets is in the range of **21 - 35 %**.

Conclusion

This article focused on the issue of assessing the safety situation in the field of fire protection. The article defined the security situation and its forms of description. In the next part of the article, two types of safety models of fire protection were proposed, namely the preventive-repressive model and the repressive model. These models were divided into two further subgroups: basic and extended model. Other parts of the article described the expression and evaluation of the degree of danger and fire risk, based on which the overall final state of the safety situation within the fire protection was subsequently determined. Within the article, a preventive-repressive model was applied as a practical example to assess the final state of the safety situation in fire protection. The given procedure and method of the evaluation were also applied within a specific area, where the overall safety situation was evaluated in fire protection. This determination of the given area's safety situation is intended primarily for the components of state firefighters, volunteer firefighters, municipalities and cities, and its main task is to minimize the breach of safety within the fire protection in the future. Based on the determination of a certain degree, fire protection units can carry out prevention in a given area. It can often be a matter of performing an inspection or tactical exercises focused on the given site. The municipality and the city can also carry out prevention in the given area through the municipality's and city's preventive activities. Based on the final state of fire risk, fire brigades, towns, or municipalities can provide educational courses and training on fire protection, whether burning in summer, ensuring regular cleaning of chimneys, or monitoring water levels during rainy days prepare for possible floods in critical areas. Ideally, the safety situation's resulting state in a given area would be updated and evaluated each year based on statistics of interventions by fire protection units for the past year.

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