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Original Paper

ANALYSIS OF FIRE CAUSES AND ASSESSMENT OF FIRE RISK (USING THE EXAMPLE OF HOTELS)

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Fire safety management in hotels is a critically important area in today's conditions. Assessing fire risks in hotels requires a comprehensive approach, which includes not only the development and implementation of effective fire detection and extinguishing systems, but also the organisation of training for staff and guests in actions in case of danger. In this context, the analysis of fire risks and fire safety management in hotels becomes extremely important to ensure the safety of all those present in hotel premises. The main idea of the article is to identify the dominant factors of fire risks in hotels in Ukraine, which contribute to the classification and identification of patterns of their impact on the state of fire safety in hotels. Based on cluster analysis, a close relationship was established between the number of fires that occurred due to malfunctions of electrical appliances depending on their type at the level of 0.98–0.88, and the degree of fire resistance and number of floors of hotels. An integral risk indicator was proposed, which takes into account three types of risks and makes it possible to assess the level of security of the hotel building.

Keywords: *fire safety, causes of fires, cluster analysis, integral risk.*

INTRODUCTION

A modern hotel is a complex, multifunctional complex that includes not only rooms, but also conference rooms, restaurants, training rooms, swimming pools, nightclubs and other entertainment and household facilities. Hotels are facilities with a mass stay of people, which places high demands on fire safety and fire protection (Koval *et al*., 2021).

In the modern world, the hotel business plays an important role in meeting people's needs for comfortable temporary accommodation. Every year, the number of hotels and the volume of their services increases, which indicates the constant development of this industry. In the conditions of war in Ukraine, the hotel industry has undergone a certain transformation. Along with the growth of the hotel sector, the risk of fires increases, which can pose a threat to the lives and property of guests and staff and cause serious financial losses.

Modern hotels are constantly occupied by a large number of people (service staff, administration, visitors, and guests), especially at night. The premises contain various engineering equipment, and there is a certain supply of flammable substances and materials. Fires in such facilities can lead to the rapid spread of fire, resulting in injuries and deaths, so it is important to investigate the causes of fires and assess fire risks.

Hotels are a class of facilities where security plays a key role. They are multi-storey buildings with a large number of rooms and long corridors (Koval *et al*., 2021; Koval *et al*., 2023a; Yemelianenko and Koval, 2024).

Ensuring fire safety and minimising fire risks for guests and their property is one of the most important tasks for owners during the operation of a hotel in wartime conditions (Nwaichi *et al*., 2024).

Hotels have different types of classifications. Hotels can be classified according to the following parameters (number of floors, number of places to stay, degree of fire resistance, type of fire alarm and fire risk management system) (Myrona and Sydorchenko, 2015; Petukhova *et al*., 2020;

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Table. 1. Hotel groups by number of floors and other fire safety indicators

Group No.	Hotel groups by number of floors	By number of places to stay	By degree of fire resistance (EN 13501-2:2007+A1:2009)	Type of fire alarm and fire management system
1.	1–2 floors	small, up to 150	all types (walls – REI 30–150, loadbearing floors – REI 15–60)	2 or 3
2.	3–5- floors	small and medium, 150–400	I, II, III (walls – REI 120–150, loadbearing floors – REI 45–60)	not lower than 3
3.	6–9- floors	medium 150–300	I, II (walls – REI 120–150, loadbearing floors – REI 45–60)	not lower than 3
4.	10–40- floors	medium and large, 300–400	I, II (walls – REI 120–150, loadbearing floors – REI 45–60)	not lower than 3, 4, 5
5.	More than 40 floors	large, more than 400	I, II (walls – REI 120–150, loadbearing floors – REI 45–60)	not lower than 4, 5

Thachuk, 2023). These parameters are interdependent, and therefore, we propose to take as a basis a combined classification by number of floors. Five main groups of hotels are distinguished by a number of floors and other fire safety indicators on which fire safety management depends (Table 1).

Modern approaches to fire hazard assessment involve the use of risk-based methods, in particular FRAME (Bukowski *et al*., 1990), which according to the SFPE Handbook of Fire Protection Engineering (Morgan and Hurley, 2016) is suitable and reliable for comparative fire risk assessments and for achieving maximum fire protection measures in buildings. The NFPA 551 standard (NEPA, 2016) also applies risk-based approaches to fire safety assessment in buildings.

The standart ISO 16732-1:2012, IDT (ISO 16732-1:2012) is dedicated to defining the principles, approaches and conceptual frameworks for the quantitative and qualitative assessment of fire risk in buildings and structures. It establishes general requirements for the fire risk assessment process that can be applied to different types of facilities and scenarios.

The above standards and methods can also be applied to fire safety and risk assessment in hotels, taking into account their specificities.

A comprehensive approach involves an optimal combination of organisational, technical, and physical measures to prevent and respond promptly to any dangerous situation in the hotel and covers the full range of forms and methods for ensuring the safety of staff, customers, and hotel activities.

The purpose of the study was to determine the causes of fires and assess fire risks (using the example of hotels).

Achieving the goal necessitated the following tasks:

– classify hotels by fire hazard factors: number of floors, number of places to stay, degree of fire resistance, type of notification system and fire hazard management;

– analyse statistical information about fires in hotels by analysing previous fire cases to identify their trends and features;

– identify the main causes of fires;

– perform multivariate regression analysis and identify dependencies;

– conduct a cluster analysis of factors affecting the spread of fires in hotels;

– develop a universal risk indicator that takes into account several types of risks and makes it possible to assess the level of building security.

MATERIALS AND METHODS

The following methods were used in the research process: analysis of the results of scientific research related to fires in hotel premises and risk assessment, fire hazard properties of materials; laboratory methods for determining the fire hazard properties of combustible materials, in particular standard methods for determining ignition and self-ignition temperatures; fire spread; statistical, cluster, regression analysis and mathematical processing of research results; statistical methods for processing the obtained research results; the FRAME method for assessing fire risks for the building and for residents, and Blong's method for assessing property risks from fire and the method for assessing individual fire risk according to DSTU 8828:2019.

RESULTS

The statistical data for the last ten years have been studied and the main causes of fires in hotels have been identified (Koval *et al*., 2023a). According to statistics, in recent years there has been an increase in the number of fires, injuries and deaths of people, and material damage from them (Fig. 1 a, b).

Based on the above statistical data, a multivariate regression analysis was performed. The dependence of the number of fires in hotels on the causes of fires in hotels was revealed, and the Fisher's criterion was determined (Tables 2 and 3).

Regression statistics were performed in the EXCEL package. Figure 2 shows the four main causes of fires: arson (A), malfunctions in electrical equipment and networks (B), mal-

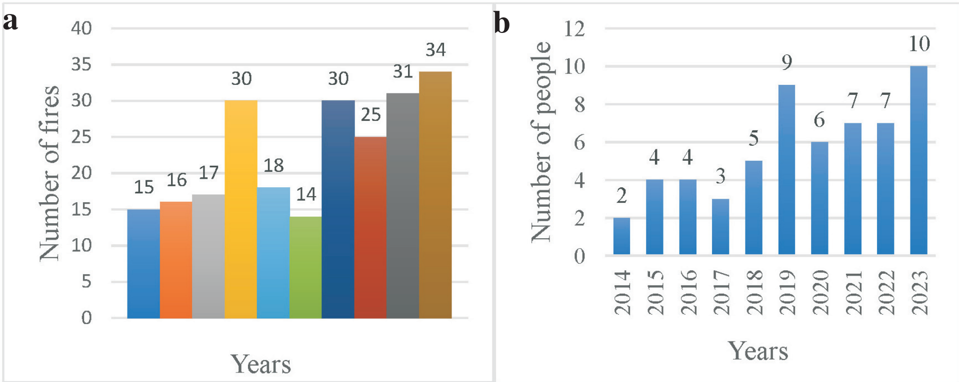

Fig. 1. Number of fires and deaths in hotels in Ukraine in 2014–2023

Table 2. Definition of Fisher's criterion

Criterion	Empirical value	Critical point
Fisher's	femp 73,40674466	fcrit 5,192167773

functions during the use of heating devices and systems (C); and careless handling of fire (D).

The coefficient of multiple determination was greatest for fires caused by malfunction in electrical equipment and networks (R^2 = 0.6315).

The coefficient of multiple determination was lowest for fires caused by arson (R^2 = 0.0779).

The main cause of fires in hotel guest rooms was carelessness in the use of electrical equipment (electric blankets, kettles, stoves, irons, razors, heaters, hair dryers), especially carelessness in turning off the equipment at night or when leaving the room.

To confirm the main assumptions regarding the causes of fires, namely electrical equipment, a cluster analysis of factors affecting the spread of fires was performed, taking into

Table 3. Regression indicators

β_4 = 0.91	β_3 = 0.78	β_2 = –1.22	β_1 = 1.47	β_0 = 0.30
$\sigma_{\beta n}$ = 0.32	$\sigma_{\beta 3}$ = 0.21	$\sigma_{\beta 2}$ = 0.08	$\sigma_{\beta 1}$ = 0.29	$\sigma_{\beta 0}$ = 1.19
R^2 = 0.98	Standard error = 1.23	-	-	-
Fisher's criterion = 73.42	Degrees of freedom = 5	-	-	-
Sum of squares of deviations explained by regression = 444.53	Sum of squares of deviations explained by error = 7.57	-	-	-

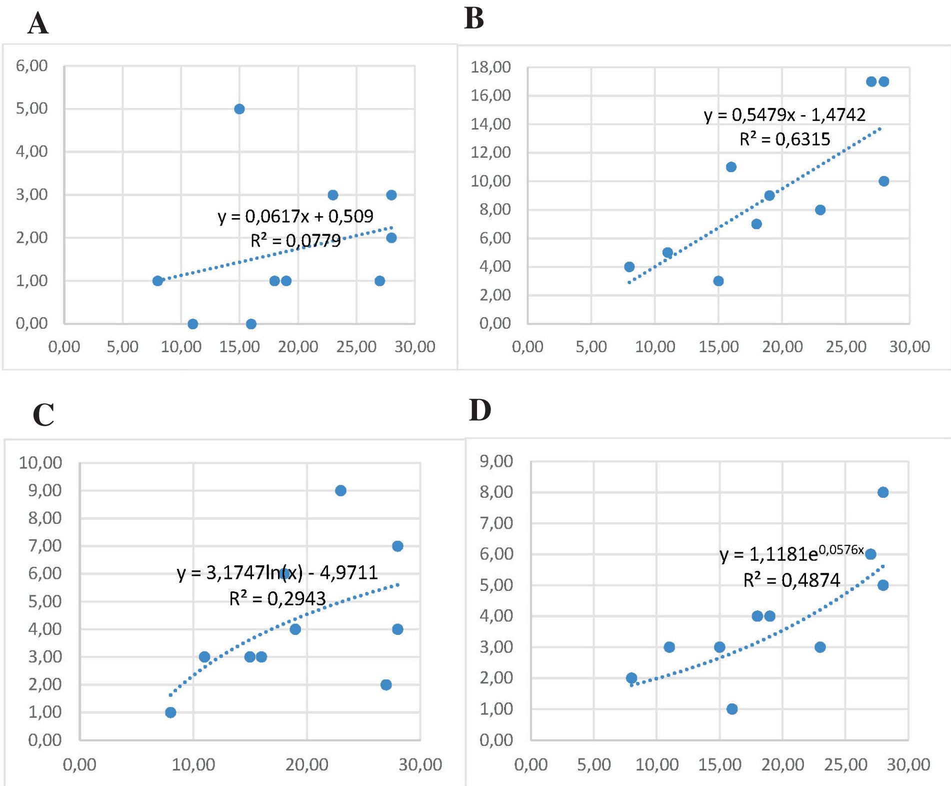

Fig. 2. Correlations between causes (A – arson, B – malfunctions in electrical equipment and networks, C – malfunctions during the use of heating devices and systems, D – careless handling of fire).

account the main places and devices that caused fires in hotels in the period 2017–2022 (chimney, extension cord, electric kettle, microwave oven, match, open fire, cigarette butt, under conditions of single-circuit electrical wiring, electric meter, electric fireplace, lamp or incandescent lamp, electrical panel, air conditioner, TV, electric dryer for textile materials, blowtorch, boiler, washing machine, flammable liquids, and other electrical products) (Fig. 3).

We observed correlation dependence at the level of 0.98 of fires due to malfunctions of electric fireplaces and other electrical products, and at the level of 0.92 for fires due to malfunctions of extension cords. Fires due to open flames or cigarette butts correlated with fires that occurred due to malfunctions of chimneys at the level of 0.92. Fires of electrical panels, air conditioners, electric dryers of textile materials and flammable liquids correlated with each other at the level of 0.9. Fires due to malfunctions of boilers and washing machines were correlated at the level of 0.89.

We observe that most fires were caused by malfunctions of electrical devices, which confirms the high coefficient of multiple determination for fires caused by malfunctions in electrical equipment and networks ($R^2 = 0.6315$).

Cluster analysis showed a relationship between the number of fires that occurred in the group of hotels with one to three floors) and the III degree of fire resistance at a correlation level of 0.98 and the total number of fires (Fig. 4).

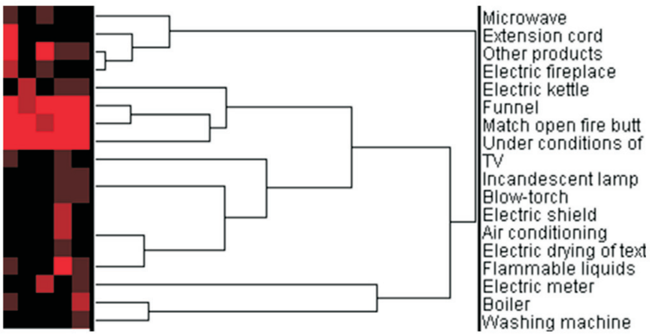

Fig. 3. Cluster analysis of locations and devices that caused fires in hotels for the period 2017–2022

It should also be noted that at the correlation level of 0.95, the number of fires that occurred on the first floor of hotel buildings is added to them, and at the level of 0.93, hotel groups 2 and 3 (from 4 to 9 floors inclusive) and the number of fires that occurred in buildings of the II degree of fire resistance are added.

By year, the most correlated years are 2017, 2018, and 2021 in terms of cumulative risk indicators at a correlation level of 0.99.

Comparison of risk indicators according to the integral fire risk indicator for hotels

In the work, the authors proposed an integral risk indicator for hotels, which involves the integration of several risks determined by several methods, each of which has its own level. Accordingly, we assigned an integral indicator to each value: green – 4, yellow – 3, orange – 2, red – 1. When comparing fire risks for hotel residents according to FRAME with residents according to DSTU 8828:2019, the dominant is an unacceptable level of risk. When comparing material losses according to the Blong method and material risks according to FRAME, the dominant is a high level of risk.

Integrated risk for hotels is a comprehensive assessment of fire hazard that combines various risk indicators determined by several methods, each of which is characterised by a level of assessment.

The following data were used to establish the integral risk indicator: fire risk for the building and for residents according to the FRAME method, property risk according to the Blong method, individual risk according to DSTU 8828:2019 (Fig. 5).

The green zone shows low-value risks that do not require any action, the yellow zone indicates the need to prepare security measures and methods, the orange zone indicates the

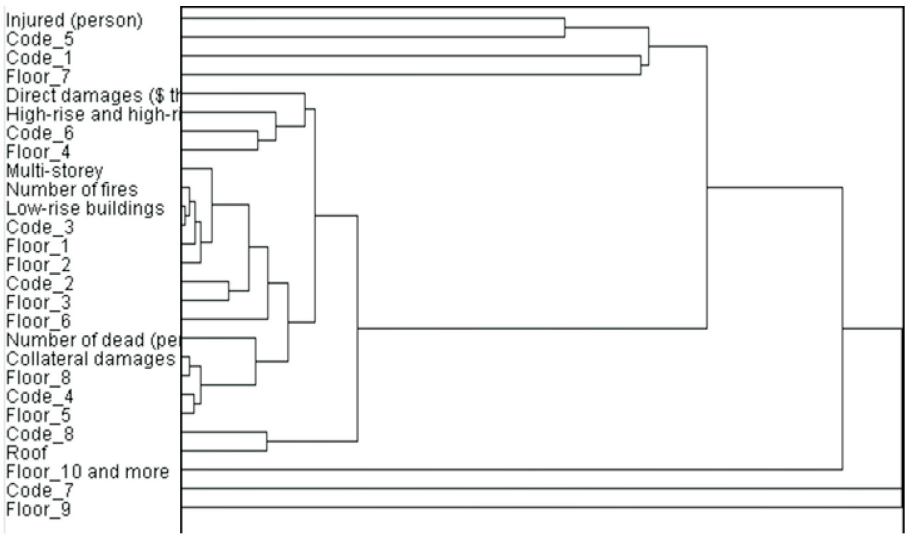

Fig. 4. Cluster analysis of hotel fire factors for the period 2012–2022

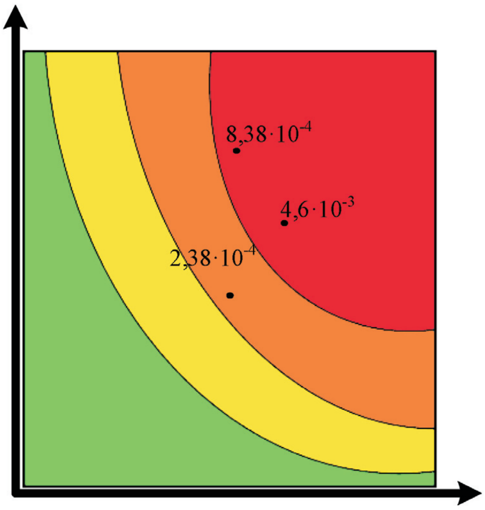

Fig. 5. Levels of risk indicators to establish the dominant ones

need to implement security measures, and the red zone indicates the need to urgently adopt security measures and methods.

Accordingly, we assign an integral indicator to each value: green – insignificant risk, yellow – acceptable risk, orange – high risk, red – unacceptable risk.

An integrated risk indicator allows you to assess risk using several methods and make appropriate decisions to minimise or control it.

This indicator is a useful tool for comparing the risk profiles of different projects and determining priorities in the allocation of resources for risk management in a hotel.

Special attention should be paid to safety issues, improving fire prevention and fire protection systems in hotels.

The lack of proper regulatory, financial, logistical, and technical support leads to the lack of an proper level of protection.

Hotel fire risk assessment using the Fire Risk Analysis Method for Engineering (FRAME). In specific cases, various analysis and calculation techniques can be used, such as analytical models, mathematical models, statistical methods, etc.

Let us calculate the risk of fire damage for a high-rise hotel in Kyiv. We will use the following data obtained from the hotel's technical documentation and expert assessments of fire safety specialists:

1. Risk to the building: q = 1.4; i =1.1; g = 1.2; e = 1.3; v = 0.8; z = 1.0; a = 0.4; t = 0.5; c = 0.3; W = 1.2; N =1.0; S = 1,5; F = 1.044.

2. Social risk: q = 1.4; i = 1.1; e = 1.3; v = 0.8; z = 1.0; a = 0.4; t = 0.5; r = 0.2; N = 1.0; U = 1.1.

3. Activity: i = 1.1; g = 1.2; e = 1.3; v = 0.8; z = 1.0; a = 0.4; c = 0.3;
d = 0.4; W = 1.2; N = 1.0; S = 1.5; Y = 1.0.

1. According to formulas 1-4, we calculate the potential risk (P) for the building

$$P = 1.4 \cdot 1.1 \cdot 1.2 \cdot 1.3 \cdot 0{,}8 \cdot 1.0 = 1.79616 \quad (1)$$

The level of acceptance (A):

$$A = 1.6 – 0.4 – 0.5 – 0.3 = 0.4 \quad (2)$$

The level of protection (D):

$$D = 1.2 \cdot 1.0 \cdot 1.5 \cdot 1.044 = 1.88 \quad (3)$$

Fire risk for a high-rise hotel building in the city of Kyiv:

$$R = 1.79616 / (0.4 \cdot 1.88) = 2.39. \quad (4)$$

2. Let us calculate the potential social risk for customers staying at the hotel according to formulas 5–7:

Potential risk (P1):

$$P1 = 1.4 \cdot 1.1 \cdot 1.3 \cdot 0.8 \cdot 1.0 = 1.6 \quad (5)$$

Let's calculate the level of acceptance for social risk (A1):

$$A1 = 1.6 – 0.4 – 0.5 – 0.2 = 0.5 \quad (6)$$

The level of protection (D1):

$$D1 =1.0 \cdot 1.1 = 1.1 \quad (7)$$

General social risk (individual risk) (R1):

$$R1 = 1.5952 / 0.5 \cdot 1.1 = 2.90$$

3. Let us calculate the risk of the hotel's activity (D) according to formulas 8–11:

Potential risk (P2):

$$P2 = 1.1 \cdot 1.2 \cdot 1.3 \cdot 0.8 \cdot 1.0 = 1.3776 \quad (8)$$

The level of acceptance (A2):

$$A2 = 1.6 – 0.4 –-0.3 – 0.4 = 0.5 \quad (9)$$

The level of protection (D2):

$$D2 = 1.2 \cdot 1.0 \cdot 1.5 \cdot 1.044 = 1.88 \quad (10)$$

The risk of activity (R2):

$$R2 = 1.3776 / 0.5 \cdot 1.88 = 1.47 \quad (11)$$

To determine the level of risk, it is important to have a comparative scale or standard criteria that are used in the context of fire risk assessment. Typically, risks can be classified as low, medium or high based on certain threshold values:

insignificant (low) risk: R < 1.0;

acceptable (medium) risk: $1.0 \le R < 2.0$;

high risk: $2.0 \le R < 3.0$;

unacceptable: $3.0 \le R$

Based on the data obtained, we have the following data for a high-rise hotel in the city of Kyiv: fire risk calculation for the building R – $2.39 \cdot 10^{-3}$, fire risk for residents (social risk) R1 – $2.90 \cdot 10^{-3}$, fire risk for activity R2 – $1.47 \cdot 10^{-4}$. Two types of fire risk (for the building, for residents) have values that fall into the high risk category, the risk for activity has a value of acceptable risk.

This means that there is an unacceptable risk of fire starting and spreading, and measures need to be taken to improve fire safety in the areas indicated.

Determining fire risks for a hotel using the Blong method. Using the Blong method, the property risk of a high-rise hotel in the city of Kyiv was calculated – height 57.5 m (17 floors, 276 rooms).

We determine the average value of the cost of one square meter of the corresponding hotel room (G) according to formula 12:

$$G = 29\ m^2 \cdot 50240\ YAH = 1456960\ UAH \quad (12)$$

We determine the "Substitution coefficient" (K_s) according to formula 2.28:

$$K_s = 35\ m^2 \cdot 3.75 / 29\ m^2 = 4.5259 \quad (13)$$

We determine the predicted value of building damage (K_d). This indicator is determined by tabular values (in our case it is 0.75):

We determine the damage coefficient (K) according to formula 14:

$$K = 4.526 \cdot 0.75 = 3.3945 \quad (14)$$

Monetary value of damage to the room (V) according to formula 15:

$$V = 3.3945 \cdot 1456960 = 4943036.32\ YAH \quad (15)$$

Therefore, the monetary value of the damage to a standard room in a high-rise hotel in the city of Kyiv is approximately 4,943,036.32 UAH.

The risk of material damage from fires or emergencies (R_d) is calculated by the formula 16:

$$R_d = 4.4 \cdot 10^{-5} \cdot 4\,943\,036.32\ YAH. \quad (16)$$

The magnitude of material losses from fires or emergencies was determined based on statistical data for the period 2012–2022 (Koval *et al*., 2023b; Yemelianenko *et al*., 2023; Koval, 2024). The green zone shows a minor risk that does not require any action, the yellow zone is an acceptable risk, there is a need to prepare safety measures and methods, orange is a high risk, there is a need to implement safety measures, and red is an unacceptable risk, urgent measures and methods to ensure safety (Tables 4–5).

Table 4. Determining risk levels using the FRAME method

Color	Value	Suggested actions	Risk level	Risk indicators
Red	Danger	Take safety measures immediately	Unacceptable risk: $3.0 \le R$	
Orange	Very carefully	Take appropriate safety measures	High risk: $2.0 \le R < 3.0$	Fire risk for the building $R = 2.39 \cdot 10^{-3}$; Fire risk for residents $R1 = 2.90 \cdot 10^{-3}$
Yellow	Carefully	Prepare appropriate safety measures	Acceptable (medium) risk: $1.0 \le R < 2.0$	Fire risk for activities $R2 = 1.47 \cdot 10^{-4}$
Green	Safety	No action required	Insignificant (low) risk: $R < 1.0$	-

Table 5. Risk of material damage from fires or emergencies

Probability of fire	Amount of damage			
	Minor	Moderate	Significant	Heavy
	≤ 10,000 thousand UAH	10000–200,000 thousand UAH	20000–60,000 thousand UAH	80000–600,000 thousand UAH
Small $\le 10^{-6}$	Green	Green	Yellow	Orange
Acceptable 10^{-6}-$5 \cdot 10^{-5}$	Green	Yellow	Orange	Red
High $5 \cdot 10^{-5}$-$5 \cdot 10^{-4}$	Yellow	Yellow	Orange	Red
Unacceptable $\ge 5 \cdot 10^{-4}$	Yellow	Orange	Red	Red

Accordingly, the comparison of the probability of fire occurrence and the magnitude of the damage according to the Blong method constitutes an acceptable level of risk of material damage.

Risks make it possible to justify the terms of insurance and carry out various measures to improve the security of the facility. The insurer is obliged, at the request of the insured, if he takes measures that have reduced the insurance risk or, conversely, increased it, to renegotiate the insurance contract with him (reduce or increase the insurance payment). In the process of any type of insurance, the parties are interested in reducing the degree of risk and preventing the occurrence of an insured event. The idea of insurance is to partially or fully compensate for losses caused by an insured event. Therefore, entrepreneurs who insure companies will always be directly interested in implementing fire prevention measures to reduce risks. Before insuring an object, insurers put forward a number of requirements that must be met (measures to reduce risks).

Everyone is interested in safety and fire risk reduction: the entrepreneur — lower insurance premiums and less risk of legal liability; the insurance company — lower losses; and staff and the public — less anxiety, increased confidence in safety under conditions of guaranteed compensation in the event of an accident.

Therefore, taking into account the common interests of inspectors of the State Emergency Service of Ukraine and insurers in reducing the risk of fires, the legislative and regulatory framework in this area should be unified.

DISCUSSION

The results of calculating individual fire risk for the corresponding scenario of fire occurrence and development are presented in Table 6.

We check the fulfillment of the safety conditions, the results of the check are given in Tables 7–8.

The individual fire risk of a facility is unacceptable per person. Therefore, there is a need to apply a comprehensive fire protection system.

Let us compare the risk indicators determined according to DSTU 8828:2019, the Fire Risk Analysis Method for Engineering (FRAME) method and the Blong method (Tables 9–11).

The FRAME method determines related indicators with the Blong method and DSTU 8828:2019, so let us compare them (risk of monetary value of damage — risk for the building and risk for residents — individual risk) (Tables 10–11).

According to the comparison of the level of monetary value of damage according to the Blong method and material risk according to FRAME, a high level of risk is dominant, which requires the development and implementation of fire protection and evacuation management systems taking into account the characteristics of the hotel.

According to the comparison of the risk for hotel residents according to FRAME with the individual risk according to DSTU 8828:2019, the unacceptable level of risk is domi-

Table 6. Results of calculating individual fire risk for the corresponding scenario of fire occurrence and development

Estimated scenario of fire occurrence and development	$Q_п$	$P_{пр}$	P_e	$K_{спз}$	$K_{о.з.}$	$K_{п.ф.}$	P_i
Facility as a whole by longest evacuation time	$4{,}4{\cdot}10^{-5}$	1	0	0,07	0,8	0	$8{\cdot}10^{-4}$

Table 7. Checking the safety condition

Estimated scenario of fire occurrence and development	Standard value of acceptable individual fire risk level	Estimated value of individual fire risk	The value of verification
Facility as a whole by longest evacuation time	10^{-5}	$8.38{\cdot}10^{-4}$	Not acceptable

Table 8. Individual fire risk assessment scale for hotels

Color	Value	Suggested actions	Risk level	Individual risk
Red	Danger	Take immediate safety measures	Unacceptable risk $\geq 5 \cdot 10^{-4}$	$8.38 \cdot 10^{-4}$
Orange	Very carefully	Take appropriate safety measures	High risk $5 \cdot 10^{-5}$–5?10^{-4}	-
Yellow	Carefully	Prepare appropriate security measures	Acceptable risk 10^{-6}–$5 \cdot 10^{-5}$	-
Green	Safety	No action required	Negligible risk $\leq 10^{-6}$	-

Table 9. Summary of risk assessment results for a high-rise hotel building in Kyiv

Risk assessment method	Risk indicators	Risk value	Risk level
Fire Risk Analysis Method for Engineering (FRAME)	Risk to the building	$2.39 \cdot 10^{-3}$	High
	Risk to residents	$2.90 \cdot 10^{-3}$	High
Blong's method	Risk of material damage	4943036.32 UAH	Acceptable
DSTU 8828:2019	Individual risk	$8.38 \cdot 10^{-4}$	Unacceptable

Table 10. Comparison of risk for a hotel building according to FRAME and monetary value of damage according to Blong

FRAME/Blong	Amount of damage			
	Minor ≤ 10,000 thousand UAH	Moderate 10000–200,000 thousand UAH	Significant 20,000–60,000 thousand UAH	Heavy 80,000–600,000 thousand UAH
Unacceptable risk 3.0 ≤ R				
High risk: 2.0 ≤ R < 3.0				
Acceptable (medium) risk: 1.0 ≤ R < 2.0				
Negligible (low) risk: R < 1.0				

Table 11. Comparison of risk for hotel residents according to FRAME with individual risk according to DSTU 8828:2019

FRAME/DSTU	Negligible risk $\leq 10^{-6}$	Acceptable risk 10^{-6}–$5 \cdot 10^{-5}$	High risk $5 \cdot 10^{-5}$–$5 \cdot 10^{-4}$	Unacceptable risk $\geq 5 \cdot 10^{-4}$
Unacceptable risk: 3.0 ≤ R				
High risk: 2.0 ≤ R < 3.0				
Acceptable (medium) risk: 1.0 ≤ R < 2.0				
Negligible (low) risk: R < 1.0				

nant, which creates a danger for the residents and staff of this hotel. Therefore, there is a need to implement an effective evacuation management system.

CONCLUSIONS

1. Based on the statistical data, a multivariate regression analysis was performed. The dependence of the number of fires in hotels on the causes of fires in hotels was revealed. Four main causes of fires were considered: arson (A); malfunctions in electrical equipment and networks (B); malfunctions during the use of heating devices and systems (C); careless handling of fire (D). The coefficient of multiple determination was the largest for fires caused by malfunctions in electrical equipment and networks (R2 = 0.6315). The coefficient of multiple determination was the smallest for fires caused by arson (R2 = 0.0779).

2. A cluster analysis was performed taking into account the main places and devices that caused fires in hotels for the period 2012–2022. We observed a correlation at the level of 0.98 for fires due to malfunctions of electric fireplaces and other electrical products, and at the level of 0.92, fires due to malfunctions of extension cords. Fires due to open flames or cigarette butts correlated with fires that occurred due to malfunctions of the chimney at the level of 0.92. Fires of electrical panels, air conditioners, electric dryers of textile materials and flammable liquids correlate with each other at the level of 0.9. Fires due to malfunctions of boilers and washing machines correlate at the level of 0.89. We observed that most fires were caused by malfunctions of electrical appliances, which confirms the high coefficient of multiple determination for fires caused by malfunctions in electrical equipment and networks (R2 = 0.6315). Cluster analysis showed a relationship between the number of fires that occurred in the group of hotels with one to three floors and the III degree of fire resistance at a correlation level of 0.98 and the total number of fires.

3. The fire risk for a high-rise hotel in Kyiv was determined using the FRAME method: the fire risk calculation for the building was R – $2.38 \cdot 10^{-3}$, the fire risk for residents (social risk) R1 – $2.90 \cdot 10^{-3}$, and the fire risk for activities R2 –

$1.47 \cdot 10^{-4}$. Two types of fire risk (for the building, for residents) had values that fell into the high risk category, the risk for activities had a medium risk value.

4. The monetary value of the damage determined using the Blong method was UAH 4,943,036.32.

5. The individual fire risk was calculated for the corresponding scenario of the occurrence and development of a fire in the hotel according to DSTU 8828:2019. The indicator was 8.38·10-4, which was unacceptable.

6. An integrated risk index for hotels was proposed, which involved the integration of several risks determined by several methods, each of which had its own level. Accordingly, each value was assigned an integrated index: green – 4, yellow – 3, orange – 2, red – 1.

7. Comparing the risk for hotel residents according to FRAME with the individual risks according to DSTU 8828:2019, the dominant level of risk is an unacceptable level. Compared the material losses according to the Blong method and the material risks according to FRAME, the dominant level of risk is a high level, which requires the development and implementation of fire protection and evacuation management systems taking into account the characteristics of the hotel.

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UGUNSGRĒKU CĒLOŅU ANALĪZE UN UGUNSGRĒKU RISKU NOVĒRTĒJUMS: VIESNĪCU GADĪJUMS

Raksta mērķis bija identificēt galvenos ugunsgrēku risku faktorus Ukrainas viesnīcās. Izstrādāts integrēts riska rādītājs, kas ņem vērā trīs identificētos atsevišķos riskus un dod iespēju raksturot viesnīcas ēkas drošības līmeni.