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THEORETICAL ANALYSIS OF THE LAW OF FORMATION OF THE RISK OF EMERGENCY SITUATIONS RELATED TO FIRES IN PUBLIC BUILDINGS

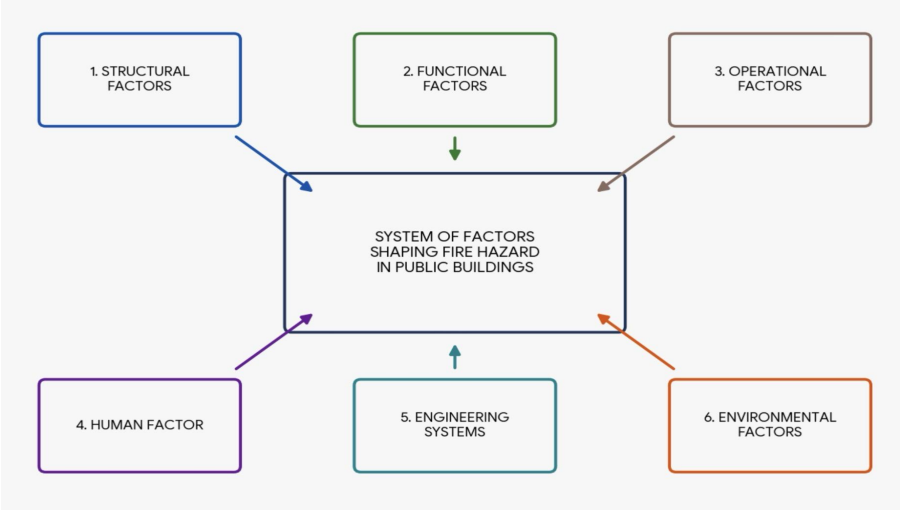
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Annotation: This article theoretically analyzes the laws of the formation of the risk of fire-related emergencies in public buildings, the mechanism of their development and the main factors affecting the safety of people. The correlation of fire spread, smoke movement, explosion hazard, engineering systems failure, and secondary hazards has been evaluated on the basis of modern approaches. Also, international scientific approaches to risk assessment and forecasting in public buildings are critically analyzed, scientifically based on the need to integrate artificial intelligence, geoengineering systems, remote sensing, seismic data and digital engineering technologies into a single intellectual engineering model. The results of the analysis serve as a theoretical basis for the development of a comprehensive intellectual model of fire safety assessment and forecasting in public buildings.

Keywords: public buildings, fire safety, emergency situations, risk formation, smoke spread, explosion hazard, engineering systems, human safety, evacuation, artificial intelligence, geoaxborot system, remote sensing, seismic hazard, forecasting.

The risk of fire-related emergencies in public buildings is a multifactorial, dynamic and interconnected process. The occurrence of a fire begins with the presence of a combustible substance, an oxidizing medium and a source of combustion. However, the risk of fire in public buildings is not limited to the combustion process. The development of fire is formed depending on the structural solutions of the building, its functional function, the state of engineering systems, the density of people and the influence of the external environment.

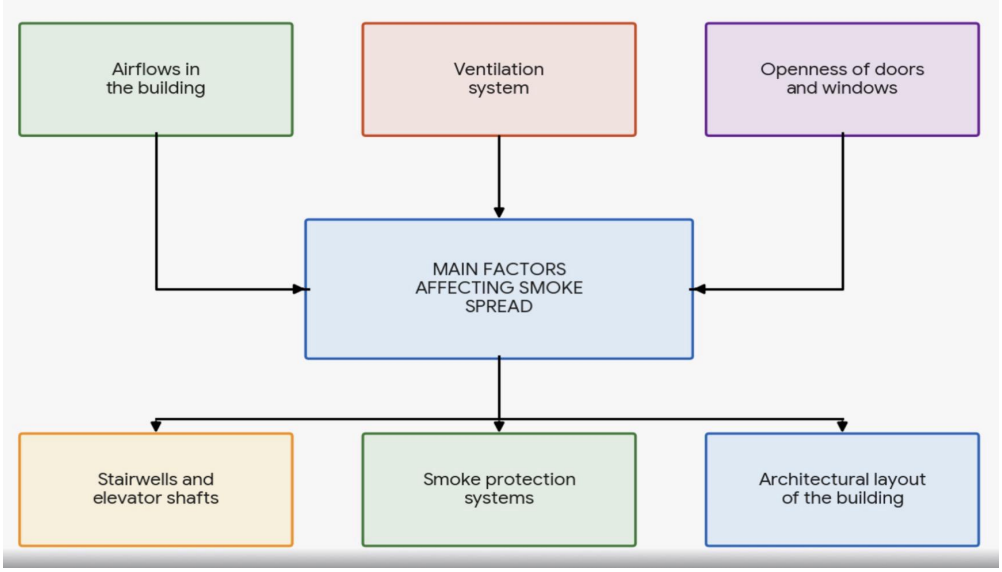
According to modern approaches, the factors that shape the risk of fire in public buildings are classified into the following groups:



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As a result of the interaction of these factors, the level of risk changes over time. The assessment of fire hazard as a dynamic rather than static system is therefore a scientifically sound approach.

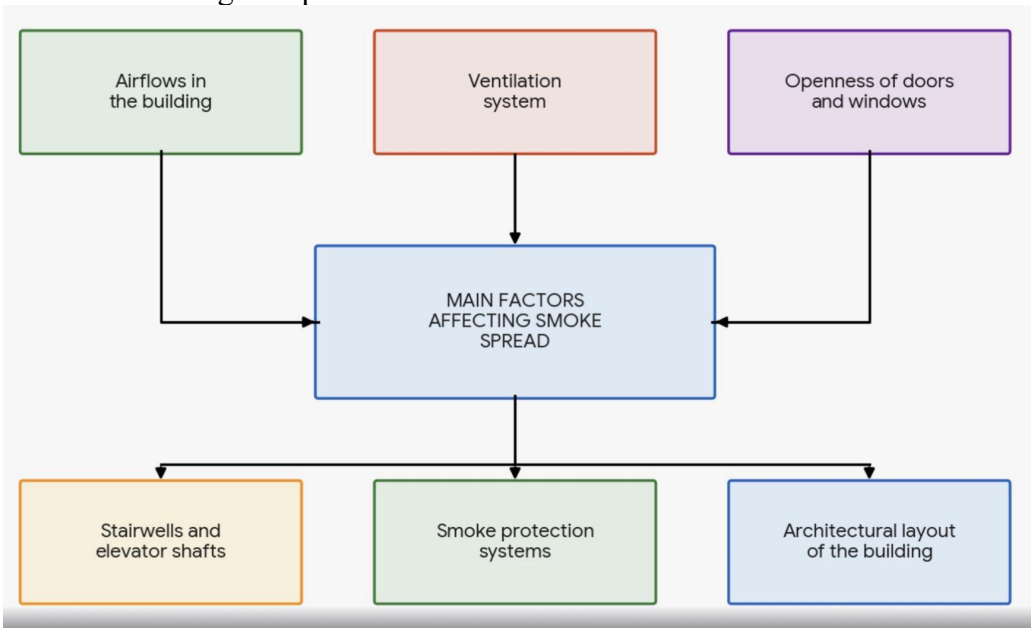
The development of fire in public buildings usually occurs at the following stages:



Each of these stages has a different effect on human safety and must be taken into account separately when assessing the level of risk.

International studies have noted that smoke and toxic combustion products, rather than high temperatures, are the main causes of human fatalities. In practice, a large percentage of fire victims lose their lives as a result of reduced concentrations of carbon monoxide, cyanide compounds, and oxygen.

The main factors affecting the spread of smoke are:



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Smoke rises rapidly under the influence of high temperatures, and then spreads in horizontal and vertical directions due to the difference in air pressure in the building. Therefore, the spread of smoke in high-rise public buildings is one of the biggest risk factors for evacuation.

In modern approaches, Computational Fluid Dynamics (CFD) models as well as software environments such as the Fire Dynamics Simulator (FDS) allow high-resolution forecasting of smoke motion.

In public buildings, fire in most cases manifests itself not as an independent phenomenon, but as a factor causing other emergencies.

Secondary risks include explosion of gas-air mixture, short circuit of electrical systems, explosion of pressurized containers, fire of fuel storage systems, collapse of structures, spread of toxic substances, panic and mass congestion.

In seismic areas, this risk is exacerbated, since as a result of damage to engineering communications caused by an earthquake, the likelihood of secondary fires increases.

In this regard, when assessing the risk of fire in public buildings, it is necessary to take into account not only the combustion process, but also the possible development scenarios of secondary risks.

Engineering systems are crucial in the safety of public buildings. Risk levels can increase several times when fire alarm, automatic fire extinguishing, smoke discharge, internal fire water supply, accident lighting, and evacuation control systems are malfunctioning.

Studies have shown that the reliability of automatic detection and early warning systems directly affects the safe evacuation of humans.

In this regard, real-time monitoring of the technical condition of engineering systems and their intellectual analysis are becoming an important component of modern security concepts.

The main criterion for assessing the risk of fire in public buildings is the preservation of human life. Therefore, as long as risk assessment models cannot be integrated with the dynamics of human action, their practical importance will be limited.

The effectiveness of evacuation is influenced by the following factors: the number and density of people, the purpose of using the building, the age composition, physical capabilities, the number of evacuation exits, the width of the exit corridors, the impact of smoke, psychological factors.

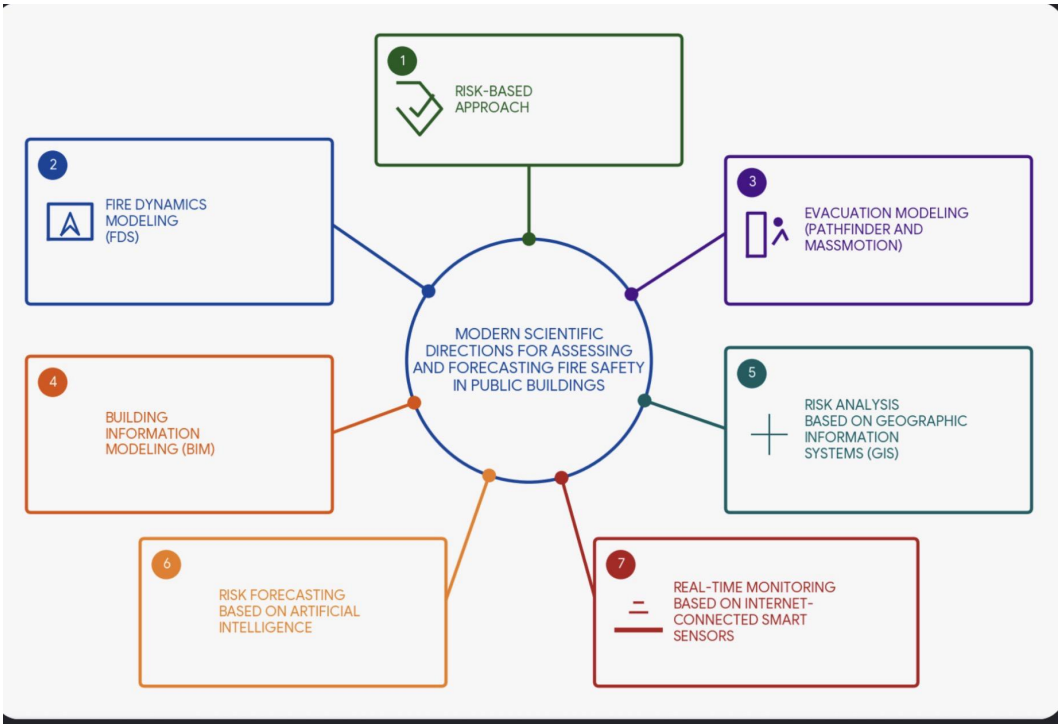
Evacuation models should also be designed in accordance with the functional nature of the facility, as the flow of people in public buildings such as a theater, shopping center, metro, Airport, Stadium or market varies.

In recent years, extensive research has been carried out to assess the safety of public buildings in the US NIST, NFPA, Lund University in Switzerland, Building Research Institute in Japan, SCDF in Singapore, as well as in EU countries. It mainly focuses on the following areas:

Most of the research in question, however, considered fire, evacuation, GIS or artificial intelligence as separate directions, which were not sufficiently developed to integrate into a single intellectual engineering model for public buildings.

The theoretical analysis carried out showed that the formation of the risk of fire-related emergencies in public buildings is multi-stage, multifactorial and dynamic in nature. The risk of fire was not limited to the combustion process, but was found to develop in relation to constructive solutions, engineering systems, the human factor, operational characteristics, external environmental influences and secondary emergencies.

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Analysis of International Studies has shown that in existing scientific approaches, fire dynamics, smoke spread, human evacuation, engineering systems reliability, artificial intelligence, geoengineering systems and digital monitoring technologies have been studied as separate areas. However, complex theoretical approaches aimed at integrating these components into a single intellectual engineering system of fire-related emergency assessment, forecasting and decision-making in public buildings are not sufficiently formed at the moment.

In this regard, it is based on the need to move from traditional approaches to assessing fire risk in public buildings to a complex intellectual approach. In such an approach, the structural features of the building, engineering systems, Human Flow, geofascial data, results of space surveillance, seismic conditions, IoT sensors, video surveillance systems and regulatory requirements should be evaluated in a interconnected way.

This theoretical analysis will serve as a scientific basis for the development of complex intellectual engineering models of fire safety assessment and forecasting in public buildings, multi-criterion integral Risk Index and decision-making algorithms based on artificial intelligence at the next stages.

Based on the results of the study, it is advisable to develop the following scientific and practical proposals.

1. The development of a multi-criterion assessment system covering the impact of structural, functional, operational, engineering, human factor and external environment, and not just fire parameters in the assessment of fire risk in public buildings.

2. The creation of a single complex intellectual expert system for public buildings on the basis of artificial intelligence, as well as the integration of building standards, fire automation, evacuation parameters and risk forecast in it.

3. Integration of Geoaxborot systems (GIS), remote sensing, satellite observations, and seismic data into the fire risk assessment model as external risk factors.

4. Development of intellectual models that allow real-time assessment of Human Flow and evacuation processes in public buildings and their connection with fire alarm and IoT sensors.

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5. Development of a methodology for the formation of a digital security passport for each public object, which includes constructive features, engineering systems, risk indicators and parameters of the external environment.

6. Development of decision-making algorithms that automatically optimize hydrants, transport routes, external infrastructure and power and tools in order to intellectually support the movement of fire and rescue units.

7. Experimental testing of the proposed models in public buildings of various functional categories in the Republic of Uzbekistan and their use in the improvement of national regulatory documents.

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