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PROPOSAL OF THE APPLICATION OF SELECTED RISK ANALYSES FOR FIRE PROTECTION

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Abstract

Currently, there are many professional quantitative or qualitative analyses for determining the risk level for different types of security. The article focuses on the proposal and characteristics of selected risk analyses, which are intended for several types of security. For each selected analysis, a method designed for the field of fire protection is proposed. The result of the article is a proposal for applying methods that determine specific forms of risk analysis within the fire protection framework to minimize the occurrence of a threat and thus prevent damage to the asset of the given object. Applying fire protection methods in the future creates additional possibilities for determining the degree of fire threats, their analysis, identification, implementation, evaluation and comparison. The main result of the article is to show readers examples of ways to determine risks in fire protection for possible future research.

Keywords: Risk Analyses; Fire Protection; Fire Safety; Methods; Safety

1. Introduction

The threat as a factor hurts the development of society. Therefore, it is necessary to deal intensively with the threats. A risk analysis is suitable for determining the threat. Risk analysis is one of the most widely used commercial or public sector methods. [1] Each risk analysis is determined differently, but each has one main goal - to determine the level of risk in a given area. One of the researched areas of risk analysis is fire protection.

Fire protection, as one of the oldest types of security, has constantly evolved to its current form. Nowadays, fire protection is found in almost every industry. According to the relevant legislation, every production and non-production facility must take fire measures to minimize threat risk. The article deals with the proposal for applying selected risk analyses for fire protection. First, fire protection, in general, is described. Subsequently, selected individual risk analyses are characterized, from which the next chapter proposes examples of the application of these analyses and methods in the field of fire protection. These are only selected risk analyses. That is, there are many more analyses for determining fire risk. The benefit of the article is a suggestion for experts in fire protection on how to analyse fire risks in buildings. [2], [3], [4]

2. Fire Protection

The fire was and still is one of the primary threats that can occur anywhere and anytime worldwide. Currently, various organizations deal with fire protection, and the legal framework solves it through laws, decrees, regulations, technical standards and the like. Fire, as well as other threats, harms our society. Therefore, it is necessary to deal with this problem and then create and apply means for its elimination to protect people, animals and property. [5], [6]

3. Characteristics of risk analyses

In this chapter, the individual risk analysis methods that will be proposed for application to issues in the field of fire protection are characterized. Specifically, it is about: Checklist, Safety Audit, What-If Analysis, Fishbone Diagram, Preliminary Hazard Analysis, Process Quantitative Risk Analysis, Hazard Operation Study, Event Tree Analysis, Failure Mode and Effect Analysis, Fault Tree Analysis, Human Reliability Analysis, Relative Ranking, Causes and Consequences Analysis, Probabilistic Safety Assessment, Bow Tie, SWOT analysis and KARS analysis. [7], [8]

4. Applying risk analyses on fire protection

Within this chapter, possible proposals for fire protection are applied to selected risk analyses (from Chapter 3). The proposed solutions and determination of selected risk analyses within the fire protection framework are based on the author's expert estimate.

4.1 Checklist

The checklist is based on a systematic check of the fulfilment of predetermined conditions and measures. Control questions are usually generated based on a list of characteristics of the monitored system or activities related to the system and potential impacts, failure of system elements and damages. Their structure can vary from a simple list to a complex form that allows the inclusion of different relative importance of a parameter (weight) within a given set. [7]

This method can be used in several ways. One way of using this method is to create a checklist for the execution of fire protection repression. Specifically, it is a list of the procedures of the fire brigade members from the receipt of the report from the operation centre of the occurrence of an emergency until its liquidation. For example, a list of house fire disposal procedures from the exit of the fire protection unit from the fire station to its return. These lists would be appropriate to apply for various fire protection emergencies.

4.2 Safety audit

A safety audit identifies risky situations and proposes measures to increase safety. The method represents a procedure for searching for a potentially possible accident or operational problem that may appear in the system under consideration. [7]

A safety audit within fire protection would deal primarily with fire prevention and its control. The safety audit would be performed by a professionally qualified person in the field of fire protection, a fire protection technician or a fire protection preventive officer. Another entity performing a safety audit would be the state fire watchdog. A license to perform would be required to perform a security audit. A penalty would be assessed to the entity for violating the rules.

4.3 What – If Analysis

What-if analysis is a procedure for finding possible impacts of selected operational situations. It is a spontaneous discussion and search for ideas in which a group of experienced people familiar with the process ask questions or express thoughts about possible accidents. It is not an internally structured technique like some others. Instead, it requires the analyst to adapt the basic concept of saving to a particular purpose. [7]

The design of the application of this analysis is the gradual creation of scenarios in the event of a fire and its consequences. Each consequence would create other consequences until the last step, where the resulting consequences would be the fire threat. The result of the method would be a retrospective comparison of which causes of the fire are the most significant and subsequently deal with them and create a safe situation as a precaution. For example, in the event of a fire, how will the fire department behave if there is an explosion or leakage of a dangerous substance.

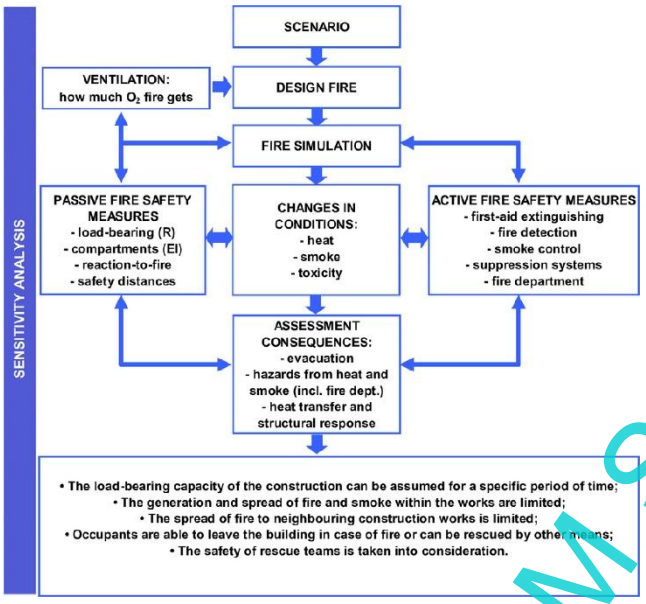

Fig. 1. Example of What – If Analysis [8]

4.4 Fishbone diagram

The method helps to model and structure a process or identify possible causes of a problem. The purpose is to determine the most likely cause of the problem being addressed. [7]

In this case, it is about determining the root cause, the gradual increase in the consequences of which can cause damage to lives or property. For example, a fire broke out in the building, and the root cause was overheating of machines and equipment.

4.5 Preliminary Hazard Analysis (PHA)

It is also called the quantification of risk sources. It is a procedure for searching for dangerous conditions and emergencies, their causes and effects, and classifying them according to predetermined criteria. [7]

This analysis would create groups from the least significant risk to the most significant. Causes would be assigned to each group, and the impacts of extraordinary events would be evaluated. For example, among the less significant risks in fire protection is the non-functioning of fire extinguishers, and among the more significant risks is improper smoke ventilation during a fire.

4.6 Process Quantitative Risk Analysis (QRA)

A comprehensive and systematic approach to predict the frequency and impact of accidents for equipment or system operation. [7]

This method would only deal with the preventive part of fire protection, where preventive measures and related activities would be comprehensively described. For example, they are solving strategic measures for the fire safety of buildings and updating legislation and technical standards.

4.7 Hazard Operation Study (HAZOP)

A procedure based on a probabilistic assessment of threats and the resulting risks. [7], [9]

This procedure would create coefficients with a certain weight and significance, from which the degree of risk probability and the possible emergence of a threat would be determined. For example, the coefficient of fire, smoke, explosion, and dangerous substance leakage would be evaluated.

4.8 Event Tree Analysis (ETA)

A procedure following the progress of the process from the initiating event through the construction of the event based on favourable and unfavourable possibilities. [7]

The method would compare the process of the preventive and repressive parts of fire protection in a favourable and, at the same time, unfavourable situation. For example, a fire incident was eliminated in a short period without harm to health, and at the same time, a fire incident lasting at least a week with a massive smoke leak, the necessary evacuation of the population.

4.9 Failure Mode and Effect Analysis (FMEA)

A procedure based on analysing failure modes and their consequences enables the search for impacts and causes based on systematic and structured equipment failures. [7]

The analysis would evaluate and create analyses of the reasons for the emergence of fire threats, where the main initiator would be the failure of the human factor, technical or natural. For example, the fire was caused by an employee smoking at the workplace, and a discarded butt caused the fire.

4.10 Fault Tree Analysis (FTA)

A procedure based on a systematic retrospective analysis of events using a chain of causes that can lead to a selected peak event. [7]

The analysis method is similar to the FMEA method. In this case, it describes the cause and the peak event. For example, failure to comply with fire safety measures resulted in a massive fire, which resulted in the loss of life of 5 employees. It compares the root cause and the worst impact of the given event.

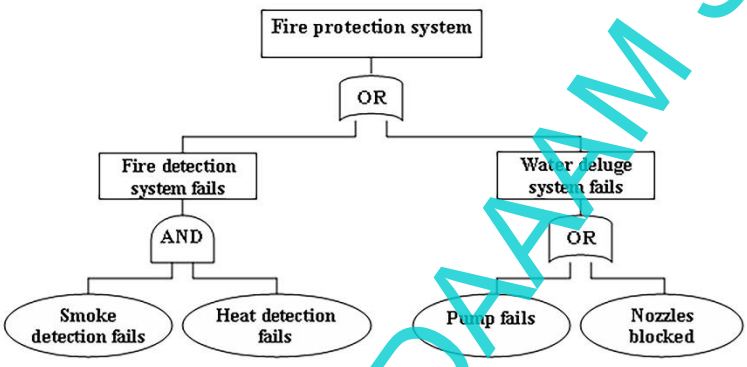

Fig. 2. Example of FTA [10]

4.11 Human Reliability Analysis (HRA)

Procedure for assessing the influence of the human factor on the occurrence of natural disasters, accidents, breakdowns, attacks, or some of their effects. [7]

In this case, it is an analysis of anthropogenic factors. That is, the cause of the emergency is the human factor. For example, a person was responsible for the threat of leaking a dangerous substance by not following safety regulations and improperly handling a dangerous substance.

4.12 Relative Ranking (RR)

An analytical strategy that allows analysts to compare the characteristics of several processes or activities and determine whether those processes or activities have sufficiently hazardous characteristics to warrant further, more detailed study by analysts. [7]

Fire protection analysts would have the primary say in this strategy. Specifically, it would be professionally qualified persons, fire protection technicians and fire protection preventionists, who all evaluate various processes and deal with a more detailed study strategy in the field of fire protection. For example, they are looking for new ways to extinguish fire using other means and equipment used today.

4.13 Causes and Consequences Analysis (CCA)

A mixture of fault tree analysis and event tree analysis. The resulting diagram of the analysis shows the relationships between the end states of the unacceptable impacts and the root causes. [7]

This analysis uses the ETA and FTA methods, resulting in an impact and cause analysis diagram. The analysis compares the ideal development of an extraordinary event with the worst possible way. At the same time, another determining factor would be monitoring root causes with the worst possible way of developing an extraordinary event. For example, the analysis follows the development of a fire with a high-speed extinguishing method and, simultaneously, with a prolonged fire extinguishing method. At the same time, this process includes looking for the root cause of the fire and evaluating the worst possible scenario of the fire.

3.14 Probabilistic Safety Assessment (PSA)

The method determines the contributions of individual vulnerable parts to the overall vulnerability of the entire system. [7]

The method primarily focuses on system vulnerabilities. As part of fire protection, it looks for the most severe vulnerabilities of the object, which can subsequently cause damage. For example, it evaluates the material from which the object is built and evaluates the fire resistance with the relevant characteristics of the material.

3.15 Bow tie

Risk visualization expresses a clear distinction between proactive and reactive risk management. [7]

This method graphically visualizes risk, especially the difference between proactive and reactive risk management. As part of fire protection for proactive risk management, it creates various safety precautions, increases frequent building checks, and adds more fire detectors and alarms. As part of reactive risk management, it evaluates how devices react reactively to the occurrence of fire and how they minimize and eliminate it. For example, it may be the risk of using sprinklers or heat and smoke extraction devices.

4.16 SWOT analysis

Analysis of strengths, weaknesses, opportunities and threats. The result of the analysis is also the evaluation of the resulting strategy, which can be offensive, defensive, liquidation or alliance. [11]

The analysis defines the object's strengths, weaknesses, opportunities and threats regarding fire protection. Weight and significance will be assigned to each part, where the most significant parts will be evaluated. An appropriate strategy will then be created from them. Analysts in the field of fire protection will further deal with the strategy and create appropriate preventive and punitive measures.

4.17 KARS analysis

Qualitative analysis using risk correlation. The analysis results in the division of risks into primary, secondary and tertiary. [11]

Based on the correlation of fire risks from the given list, the KARS analysis evaluates individual risks through the coefficient of activity and passivity. It divides them according to significance into primary, secondary and tertiary. For example, the primary risk of an object is fire, leakage of a dangerous substance or explosion. Secondary risks include overheating machines and equipment, blocked escape exits and insufficiently trained personnel. Tertiary risk includes an insufficient number of fire extinguishers in the workplace.

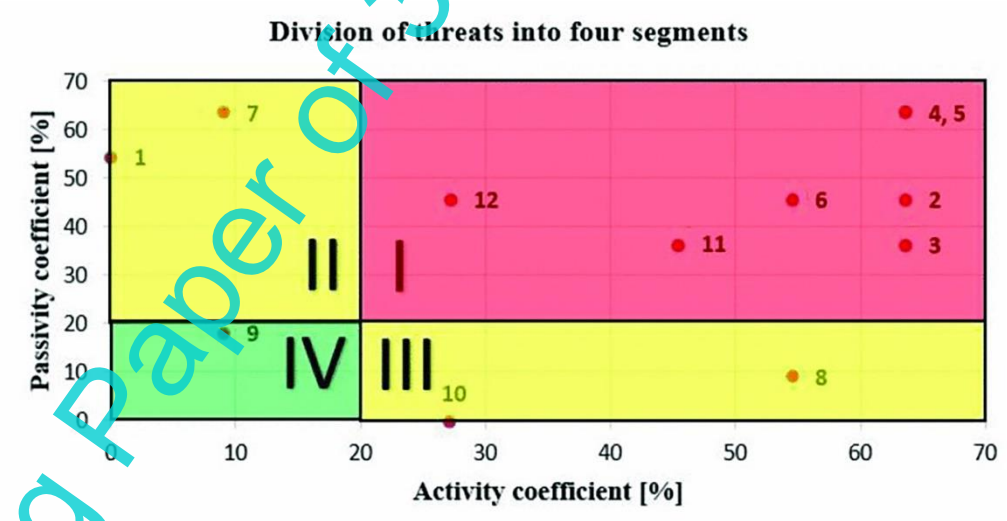

Fig. 3. Example of KARS analysis [11]

The chapter dealt with the characteristics of risk analyses, followed by their possible application proposal. For each risk analysis, a fire protection risk assessment method is proposed.

5. Conclusion

Risk analysis is one of the most important methods of determining the safety of an object. The object's risks also include risks in fire protection. The article dealt with the characteristics of selected risk analyses, followed by a proposal

for a possible application in fire protection. Firstly, the chapter describes fire protection in general. The following chapter deals with the general definition and characteristics of 17 risk analyses, where a possible proposal for applying these risk analyses to the field of fire protection is presented, and specific examples for each analysis are also given. These suggestions suit all those who deal with fire protection, risk analysis, prevention experts and other interested people as a way of possibly implementing risk analysis to minimize them. In order to compare results from other sources where risk analysis is applied, the result of the article is also a brief overview of selected risk analyses.

The limit of the article is the use of only selected risk analyses, which are usually evaluated separately or differently.

In the future, it is appropriate to apply these risk analyses to fire protection and to evaluate the probabilities and rates of occurrence of risks and thereby minimize them, whether from the preventive, proactive or repressive part of fire protection.

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