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Methodology for evaluating the effectiveness of alarm systems

Abstract. *Alarm systems are one of the parts of protection and security systems. In combination with other elements, it provides security for selected assets and contributes to their protection against various risks. The article deals with the description of the development and, at the same time, current trends in evaluating the effectiveness of alarm systems to point out the connection between methods and software tools.*

Streszczenie. *Systemy alarmowe są jednym z elementów systemów ochrony i bezpieczeństwa. W połączeniu z innymi elementami zapewnia bezpieczeństwo wybranym aktywom i przyczynia się do ich ochrony przed różnymi ryzykami. Artykuł dotyczy opisu rozwoju i jednocześnie aktualnych trendów w ocenie skuteczności systemów alarmowych w celu wskazania powiązań metod i narzędzi programowych.. (**Metodologia oceny skuteczności systemów alarmowych**)*

Keywords: Alarm systems, Software, Evaluation, Efficiency
Słowa kluczowe: systemy alarmowe, oprogramowanie, ocena, wydajność

Introduction

The use of alarm security systems is currently an increasingly common phenomenon. Interested parties can follow the financial value of the system and compare it with the protected property. However, it is only sometimes possible for a user, whether from a number of citizens or owners of corporate companies, to correctly evaluate the effectiveness of these systems. Manufacturers and system designers have been dealing with the efficacy of selected protective elements for many years. At the state level, these assessments belong to a critical area. As threats and risks evolve, so do the requirements for protection systems and their evaluation.

The importance of evaluating the effectiveness of systems for object protection

The effort to secure property not only against natural influences has accompanied humanity since time immemorial. Since the beginning of civilization, people have protected their dwellings with ramparts, walls and ramparts. With further development, security systems also developed, which always reacted to new events in an attempt to prevent them in the future. This is how a simple lock was added to the door, which continued to develop mechanically, and today we lock doors using chip cards. The effort to be informed about danger promptly certainly contributed to the development and creation of the telegraph or telephone. The need for a single place to send help gave rise to the centralized protection desk. It would be possible to continue this way until today when we still perceive technical progress.

Currently, the following parts of security systems and their mutual combinations are used:

- Alarm security and emergency systems (I&HAS)
- Electrical fire protection systems referred to by the abbreviation
- Camera systems (CCTV)
- Mechanical security systems
- Access systems

[1] [2]

System Requirements

Many manufacturers and companies are involved in the production or installation of security systems. For all of them, the standards of the relevant states are central, which sets the requirements for individual systems. As part of the fire protection of buildings, which is also related to protecting human lives, it is also necessary to follow the relevant laws. Each alarm system project must ultimately be based on individual requirements resulting from certain specifics. Other laws, regulations and standards can also play their role.

All system requirements can be divided into several areas. Among the main ones are the functions that need to be used to detect intrusion into the guarded area and to activate emergency means. Then quickly process the resulting information and declare an alarm. At the same time, the system should identify possible malfunctions and false alarms. These functional requirements must correspond to the already mentioned standards. Another paramount requirement is directed at the individual components, which must be mutually compatible within the system. Adding each component is possible, but it must again work correctly with the original ones. Each system is rated with a security level, so the last primary system requirement is to determine the security level.

The following are the power requirements. The alarm system can be powered in three primary ways when it is powered from the classic electrical network, and in the event of a failure, even intentional, power is supplied from the accumulator or battery. In certain cases, the operation of the system can only be ensured by spare sources or only batteries.

Other important areas are reliability, both operational and functional, and electrical safety. We should also remember the surrounding environment's influence and protection against higher temperatures, possible humidity, and electromagnetic interference from other devices.

When all legal and system requirements are met and determining the individual system requirements, and subsequently the entire selected system, the nature of the object, the risks it may face, and a certain user suitability must always be taken into account. The relevant legislative obligations must be addressed too.

After all legal and systemic requirements have been met, it is necessary to deal with the system's effectiveness. This value does not have to be set by any standard or law, but it can be crucial for project contractors. [1] [2]

Methods of evaluating the effectiveness of object protection systems

As already mentioned in the previous section, alarm systems' effectiveness and evaluation belong to essential values, compatibility, and low error rate.

Development of methods

In 1991, the Analysis of the effectiveness of the safety protection system of nuclear equipment and materials was prepared. In which it is mentioned the importance of

evaluating the effectiveness of alarm systems in the terminology of the time. The material is based on international studies and cooperation. It states here the necessity to model possible situations of disruption of spaces and to evaluate the paths and methods by which the goal of the intended attack can be achieved. The result of the evaluation is subsequently the determination of whether the chosen system is compelling enough. [3]

The tools are based on specific, measurable values, based on which it is possible to estimate the probability of eliminating an intruder's attack. They include fundamental quantities for evaluating the effectiveness of protection. It is about:

- Probability of detecting an intruder at a specific time and place
  (PDi - Probability of Detection)
- Response Force Time (RFT – Response Force Time)
- Breakthrough resistance of the system (DT – Delay Time, Time Remaining)
- Probability of correct and Timely Guard Communication (PC – the probability of correct and Timely Guard Communication)

Subsequent models and studies based on the mentioned quantities were the basis for creating and developing current computer models designed for more accurate calculations and overall efficiency.

a) EASI model

This is an undemanding method with easy implementation and the possibility of changing the input parameters and their numerical evaluation. The result of the method is a numerical devaluation. The expressed estimate of the probability of eliminating the problem is calculated from the relationship between the probability of detection of the intruder and the probability of an appropriate response of the intervention unit.

Disadvantages include the ability to estimate the probability of eliminating an attack on only one path. Unfortunately, the method does not calculate the vulnerability of the entire system and, at the same time, does not model the elimination of the intruder. [3] [4]

b) ASD method

This method graphically represents physically separated spaces in the object and the possible paths between them. The evaluation of effectiveness is subsequently expressed using the critical approach. At the same time, the method uses the principle of the EASI method. [3] [4]

c) SAVI method

It combines the ADS diagram and the EASI model and estimates the effectiveness of the protection system against the theft of guarded assets by both external and internal intruders. The effectiveness of the system is expressed by the probability of eliminating the mentioned intruders within the individual possible attack paths. As part of implementing the method, it is necessary to identify the attack's potential targets to determine the attacker's essential characteristics. The space owner must have an overview of the elements that protect the property and the time the emergency unit can react.

The mentioned procedure was the basis for creating the software, which works with a relatively extensive database of protective elements. [3] [4]

d) ASSESS method

As part of the development, the ASSESS method replaced the SAVI method. The subsequently developed software tool consists of several modules, which were supposed to assume the possible cooperation of own employees with possible intruders, then to determine the effectiveness of the intervention unit and to analyze the elements of protection. [3] [4]

Since the 1970s, the effort to build a suitable software tool has given way to other methods and software products. These include the abbreviated instruments BATLA, VISA, ISEM, FESEM, SAVA and SNAP. Most of them are currently no longer in use. However, these tools gave birth to other, more modern software programs. Among them was a module for training commanders of intervention units called JCATS, UUCAST, JTS.

The present

In his professional article, Ing. Jan Valouch, PhD., elaborates on the method of aggregated coefficients. This method is based on the evaluation of the requirements determined by the relevant technical standards. It also includes the influence of individual components and their mutual integration. It considers parameters from the areas of security requirements, which are based on levels and classes of security. The second area, which is also based on the standards' requirements, is the systems' technical properties. The system application parameters compare the individually designed parts of the alarm system and the scope of the guarded object. In the case of connecting multiple systems, the integration parameter is calculated.

Individual classes and groups are assigned a numerical rating within the proposal. The coefficients are subsequently expressed as an arithmetic mean. The individual resulting values express the resulting efficiency. [5]

System efficiency can also be viewed as total attack time. It is calculated either from the first evaluation of the area violation until the attacker leaves the area, or as the time from the penetration into the guarded area until the time of the intervention of the security service.

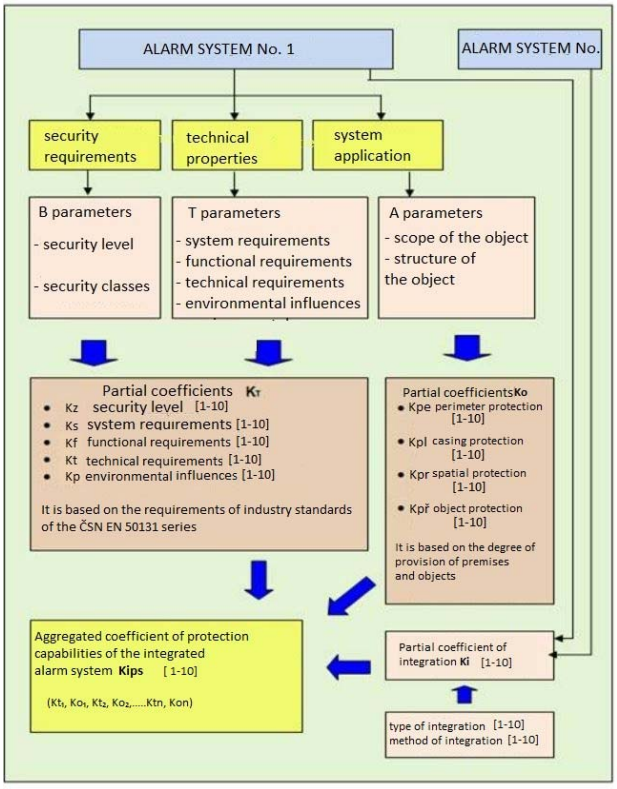

Fig 1 - Design of links between areas of parameters of effectiveness of alarm systems [5]

Effectiveness criteria of active and passive elements:
a) Detection using active elements

b) Intrusion detection using physical protection

This coefficient indicates the probability that the intervention unit will succeed in detaining the attacker and preventing him from further progress. [4]

c) Evaluation of the effectiveness of the security system

A system can be characterized as effective when the time required to overcome it is longer than the arrival time of the emergency unit. [4]

d) Criteria for the effectiveness of motion detectors

Motion detectors are active protection elements. A direct ratio applies here. The higher the number of detectors, the higher the protection obtained. [4]

Software tools

Software tools developed from previous methods can be further divided into qualitative and quantitative according to approaches.

a) Qualitative approach and tools

A qualitative approach to evaluating the effectiveness of alarm systems is based on expertise and accurate expert and expert estimates based on established regulations and technical standards. Although the method is more or less judgmental, it has given rise to software products called RISKWATCH from the US-based company Risk Watch International develops. In its description, the company says it provides security and risk assessment platforms that can be used to find compliance of security device results with requirements. He presents his approach to evaluating the effectiveness of one or more devices as part of the basic steps. By entering input information about the settings of system elements, it further works with risks that could occur and calculates the probability and potential impact on protected assets. It then generates a list of possible security risks from the information obtained and recommendations for their elimination. In addition, it divides the guidance into individual steps so that security gaps are eliminated.

The platform is user-friendly, and of course, there is also an application for mobile phones. At the same time, the company constantly aims to improve functions and react to developments in security areas. The list of references from multinational companies may testify to a wide field of activity and client satisfaction.

The disadvantage of only a qualitative approach to the evaluation of the effectiveness of alarm systems is the fact that it cannot assess whether the system is undersized or, on the contrary, oversized. [6] [7]

b) Quantitative approach and tools

Mathematical calculations and other statistical methods are the basis of quantitative approaches to assessing effectiveness. Input information must therefore be measurable and clearly demonstrable. The conclusions are subsequently expressed in measurable units and make it possible to verify whether the system is oversized or undersized in contrast to qualitative approaches. Other results found establish effectiveness, efficiency and reliability. The input sources are mainly time units, which include, for example, breakthrough resistance time, alarm announcement time, a response time of the emergency unit and its intervention, alarm announcement, time of movement and eventual escape of the intruder after the monitored objects.

The software tools then determine the effectiveness using the calculations of the coefficients of the efficacy of protective measures, the probability of eliminating the intruder and the critical point of detection. [6]

They develop software tools, for example, in the Russian Federation, South Korea, the Slovak Republic and the USA, which include:

• Vega-2 (Eleron, Russia)

It is a software tool intended to determine the effectiveness of the physical protection system of nuclear facilities and model the possibilities of external and internal intruders. [6] [7]

• SFZ Analyzer (Russia)

It is a specific tool that can calculate the shortest time the alarm system can be overcome. [6] [7]

• Sprut (ISTA, Russia)

The third Russian software tool, which is used to evaluate the effectiveness of safety systems in the field of nuclear energy. It specializes in modelling combat encounters and the use of physical force. [6] [7]

• SAVI/ASSESS (Sandia National Laboratories, USA)

The SAVI software combines the adversary disruption estimation value, which is dealt with by the already mentioned EASI method, and the ASD method, which graphically depicts the possible paths between spaces and the critical way. At the same time, it compiles a list of the most vulnerable places. The sister module ASSESS expands the SAVI software to neutralize intruders and any relationships between them. [6] [7] [8]

• SAPE (Korea Institute of Nuclear Non-proliferation and Control, South Korea)

The Korean software builds on previous products, improving them with sensitivity analysis and using 2D models to replace the ASD method. [6] [7]

• SATANO (the University of Žilina in Žilina, Slovak Republic)

For 15 years, the University of Žilina has been developing this specific software tool intended for evaluating the effectiveness of security systems. Its main principle is the connection between mathematical models and social aspects of physical protection. A specialized polygon is also used for development, representing a map of the object, within which it is possible to measure individual required times and subsequently express probability values. Experts estimate unmeasurable input values. Within this tool, a qualitative and quantitative approach to evaluating effectiveness is connected. [7]

Fig 2 – SANATO software tool version 2.0. [7]

Comparison of methods and SW

The given information proves the complexity and difficulty of evaluating the effectiveness of alarm systems. Individual methods always focus on a specific part of the required output values. The setting of specialized software tools is subsequently based on the methods. At the same time, they try to connect individual techniques to provide sufficiently accurate information.

An important fact is that all tools continue to develop dynamically and thus respond to societal developments.

Comparison of methods and their mutual evaluation is, therefore, clearly not possible. The companies involved in developing SW tools do not publicly state the prices at which the tools can be purchased. Systems for evaluating the protection of nuclear facilities will undoubtedly fall under special regulations, and even here, their value is, certainly on purpose, not published. The most appropriate approach to ensuring evaluation is linking individual strategies and evaluating a specific system setting.

Conclusion

The article dealt with new trends in evaluating the effectiveness of alarm systems. Individual asset security requirements were described. Due to the fact that security is not only an extensive topic but also a topic that has been in society for many years, the development of approaches and methods was also described. The digital age brings requirements for software processing practically all data, both at the input and output. The development of specialized evaluation programs is subsequently based on this approach.

The fact that it will be necessary to work with citizens' psychological behaviour and project this aspect into software products is newly emerging in the professional literature. International Internet companies collect data on users' behaviour, preferences and interests and can work with and evaluate them in detail. The observed trends can have a significant impact on understanding the characteristics of the behaviour of certain groups of the population and on predicting behaviour in certain situations. In the future, companies may proceed to connect technical perspectives on ensuring security with the knowledge of anthropology.

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