

Propedeutics of safety engineering of anthropogenic objects

Introduction

An important problem in the development of modern technology is safety engineering of anthropogenic objects to implement a variety of human needs - covering a range of theoretical and practical security issues concerning man-made objects in the following areas: technical, economic, legal, organizational and logistical. The processes of designing, making, distribution and operation of facilities anthropogenic object all involve safety issues. Due to the wide recognition of the problem formulated in this paper, the author has made an attempt to clarify a number of important concepts involving the issue of safety engineering of anthropogenic objects, such as the environment, human needs, the consumer, the object of human activities, security, threat, security engineering.

Key words: security engineering, anthropogenic facility, legal regulations

Propedeutyka inżynierii bezpieczeństwa przedmiotów antropogenicznych

Wprowadzenie

Istotnym problemem w rozwoju nowoczesnych technologii jest inżynieria bezpieczeństwa obiektów antropogenicznych w celu realizacji różnorodnych potrzeb człowieka - obejmujących szereg teoretycznych i praktycznych zagadnień bezpieczeństwa dotyczących obiektów wytworzonych przez człowieka w następujących obszarach: technicznym, ekonomicznym, prawnym, organizacyjnym i logistycznym. Procesy projektowania, wytwarzania, dystrybucji i eksploatacji obiektów antropogenicznych wiążą się z kwestiami bezpieczeństwa. Ze względu na szerokie uznanie problemu sformułowanego w tym artykule autor podjął próbę wyjaśnienia szeregu ważnych pojęć dotyczących inżynierii bezpieczeństwa przedmiotów antropogenicznych, takich jak środowisko, potrzeby człowieka, konsument, przedmiot działalność człowieka, bezpieczeństwo, zagrożenie, inżynieria bezpieczeństwa.

Słowa kluczowe: inżynieria bezpieczeństwa, obiekt antropogeniczny, przepisy prawa

The human environment

In accordance with Art. 3 Section 39 of the Environmental Protection Law of 27 April 2001(Dz. U. 2013, pos. 1232 as amended), the concept of the environment is generally understood as all natural elements, including those transformed by human activities, and particular areas of land, minerals, water, air, landscape, climate, and other components of biological diversity, as well as the interactions between these elements.

The environment is a natural place of all social life. Man lives in and manages specific environmental conditions, uses its resources, transforms elements of the environment and introduces new components - the products of their own development. Taking into account the level of transformation of the environment (anthropopression) by the man, S. Leszczycki [13] mentions:

- the natural environment (the nature), a set of natural elements in a given area. It is assumed that an area can be called the natural environment when the degree of conversion of its components by the man does not exceed a few percent. Currently, on the Earth such areas are circumpolar areas, desert, alpine and the lowermost parts of ocean beds;
- geographical environment (the transformed) is defined as a set of natural elements transformed in more than 50% and of artificial elements, i.e. settlements, industrial, agricultural and transport infrastructure;
- anthropogenic environment (the artificial) is geographical environment saturated with products of human development in about 90%, for example urban and industrial areas.

All components of the environment are on the surface of the Earth, inside the Earth's crust and in the troposphere, which is a three-dimensional geographical space. The boundaries of the geographic space are now lower limit of the crust and the upper limit of the troposphere. All the natural elements of the environment are closely interrelated and interdependent. Together they form a complex, pervasive ecosystem. Changing one of the elements of this system will affect its other constituents. All ecosystems are based on the same principles of flow and conversion of energy. Therefore, they have the ability to self-regulate, which allows for maintaining the state of natural balance. On the other hand, disorders relating to individual components of the ecosystem can disrupt the whole of the ecosystem. The larger these disorders are the longer it takes the entire ecosystem to return to the state of equilibrium. If problems in the ecosystem are too big, the ability of the environment to self-regulate is disrupted, and a return to the natural balance is not possible. The environment is then irreversibly degraded.

This article deals with anthropogenic environment (the artificial), or geographical environment saturated with products of human development, which includes anthropogenic objects created to enable the satisfaction of various human needs. An important objective of safety engineering is the creation of such objects that allows the satisfaction of specific human needs that do not endanger the health or safety of human life due to improper design and construction in functional - operational and constructional – material areas. Implementation of this objective is the main problem of anthropogenic objects safety engineering [2, 3, 4, 5].

The concept of human needs

A need is a property of the human body that leads to a state in which a person cannot function normally (to use their abilities in action) and develop irrespectively of certain conditions. Unfulfilled need leads to a state of tension that requires discharge. In other words, the need is a desire, willingness, and sensation. In human life, needs play a significant role. They have a decisive impact on the lives and actions of people. They are factors driving human activities aimed at satisfying them.

The main sources of needs are:

- the human being, in particular their physical and spiritual needs,
- the natural environment, climatic conditions,
- socio-economic life

Needs can be divided into two groups:

- **Natural needs** (called physiological, elementary, basic) associated with the biological conditions of human existence and physiological activities of the body. These include the need to diet, dress, housing and recreation. They are related to the maintenance of human life and physical fitness. The satisfaction of physiological needs is a prerequisite for human and biological life;
- **The needs of a higher order** (also known as mental, or secondary) arising out of the human psyche and its relation to the natural and the social environment, such as: the needs of security, employment, upbringing and education, culture and tourism.

The above-mentioned groups include the following needs:

- Physical and mental
- material and cultural,
- objective and subjective,
- single and repetitive.
- complementary and substitutable,
- individual and collective,
- potential and efficient,
- present and future,

Needs are an internal factor related to the functioning of the human body, and their role is to stimulate organism to act in order to meet the resulting incentive tension. Thus, a need does not motivate constantly, it is activated only when it is unfulfilled.

All sorts of tangible and intangible goods allow for realization of human needs. In economics, goods are means that can be used, directly or indirectly, to meet human needs. The main interest here is tangible material objects - designed to meet a specific need or needs. Material goods, capable of fulfilling human needs can be divided into [18]:

- **natural goods** - made by nature and
- **anthropogenic goods** - man-made.

Our interest is in anthropogenic goods - also called economic goods - that is, all the materials produced by the man in the production process in order to meet human needs.

Concept of security

Security is an interdisciplinary concept and the exploration of its aspects is involved in many different fields of science. These include history, psychology, sociology, law, political science, military science and much more. As rightly pointed out by K. Gołaś [7] „...from the wealth of sciences dealing with this problem it can be concluded that the concept of "security" is very extensive in terms of meaning and definitions - because every branch of science deals with various aspects of security”. R. Klamut [9] states that „...the concept of security is an ambiguous concept, and depending on the area or areas of knowledge analysis is variously understood. In addition, it can also be combined with other concepts, and thus allows for more

semantic contexts. As a result, there is a great variety and often a lack of clarity about the meaning of security. In the situation when the same terms are used in many fields of knowledge or when concepts are interdisciplinary, there is a danger of inadequate understanding of the importance of specific research for a specialty or field of knowledge". L. Korzeniowski [11] indicates the possibility of understanding 'security' in several ways: as a need, value and sensation.

The present work aims to characterise security in relation to technical objects created for the realization of a variety of human needs.

The simplest meaning of this term can be drawn from the etymology of "security". In Latin, the term "security" – "securitas" consists of two parts: sine (without) and cura (worry, fear, fear) and indicates that it means "the state of security, peace, confidence, lack of worry and fear, confidence and protection against the dangers" [1, 9, 10, 19,20]. Also, the American psychologist A. Maslow [14] developing a hierarchy of human needs, categorized the need for security (certainty, stability, support, care, freedom from fear, anxiety and chaos) in the second place, just after physiological needs - necessary to sustain existence - recognizing that satisfaction of the need for security is essential to healthy functioning.

Security issues have absorbed humanity since its inception. P. Barciak, discussing the essence of safety [1], states that "the man has always stood in the face of various threats, and the struggle for existence, survival and care to ensure the safety of himself and the closest relatives has become his natural need. With the development of civilization and the changing world the need for security is not decreasing. On the contrary, it is growing and has become even more complicated. For the humankind the guarantee of survival was not sufficient. The man wants something more: stability, predictability, development, prosperity... ". One must therefore agree with the statement by J. Stańczyk [21] that „Security is the principal need of individuals and social groups, and also their most important objective. Security is an existential need – it concerns the existence of an individual”.

The need for safety is manifested in social and interpersonal forms, and it creates the basis for the organization and functioning of everyday life at all levels of the society – from the individual to the national one. Security in terms of the needs of the public includes protection of existence, survival, safety, stability, identity, independence, protection and quality of life [1,19,20]. That versatility makes it not only the supreme need of humans and social groups, but also the basis for the functioning of national and international systems [8, 23]. Its lack causes anxiety and insecurity, and the task of the state is to eliminate, or at least minimize the threat, anxiety and uncertainty caused by fear, thereby creating optimal conditions for citizens to develop. Given the above, it can be concluded that to provide security - is to be able to meet existential needs of an individual, as well as to provide opportunities for an individual to secure himself his existence, survival and development by himself. Security is also a state of certainty as to the above possibilities. Security is a state of certainty and guarantees its maintenance, giving a sense of stability and allowing for further development of the individual. This need for order and harmony is one of the basic existential needs of man and is characterized by a lack of fear of loss of values, such as life, health, affection, respect, work, or goods, both tangible and immaterial [14, 16, 17]. In this context, security is treated as a factor that elicits an action if its absence is felt. Thus, a security risk constitutes the motivation to take action to restore security.

This threat does not have to actually exist. It is just enough that a man predicts a possible threat to his security.

To summarize the theoretical considerations about the concept of security and its nature, it is reasonable to quote the definition of the concept adopted by S. Koziej [12], according to which most commonly „...safety is defined as both the state (achieved sense of security of a human being) and process (providing a sense of security for them)”. The latter is a more practical approach as one reflecting the natural phenomenon of the dynamic nature of security.

In this sense, security of an individual is the area of his activity which consists in ensuring the survival (existence) and the freedom to pursue his interests in a dangerous environment, particularly by exploiting opportunities (favourable circumstances), to meet challenges, reducing risk and preventing (prevention and opposition to) any kind of threat to his life and interests. From the work [12] it follows that risk assessment is undoubtedly an underlying factor when it comes to solving the most important security problems.

Main threats, and hence the state of security, are often dealt with in a dualistic manner of dividing the safety of an anthropogenic object internal safety and external safety - which is due to anthropogenic functioning of each object in a given environment, which constitutes "surroundings" of an object [2, 3, 4, 5]. The concept of "safety of anthropogenic objects" includes two aspects: internal and external, depending on where they are located and where threats originate:

- **Internal security** means lack of danger for the individual using a particular anthropogenic object to meet the needs generated by the anthropogenic object;
- **External security** lack of danger for other objects in the environment of the individual using or the anthropogenic object to meet the needs generated by the anthropogenic object.

By combining internal and external aspects of safety of anthropogenic objects, one can afford a comprehensive grasp of the safety of a facility [3, 4]. The concept of safety of an anthropogenic facility involves such areas as economic, social, military, public, environmental, information, logistics, etc.

The concept of danger

As is clear from the above observations, defining security one should also be aware of its relationship with the concept of danger. Semantically, "safe" means something protected from danger. This suggests that the state of jeopardy bears primacy over safety. The phenomenon of the threat has two aspects: the subjective - existing only in the sphere of awareness of an individual, or a feeling or perception of their situation as hazardous; and the objective - that is actually occurring events and phenomena that cause anxiety and threaten an individual [19, 12, 21].

J. Stańczyk [21] sees the essence of safety in the analysis of objective and subjective aspects of the threat. A similar approach, in this respect, represents T. Kołodziński [10], who emphasizes that the threat perception is subjective in nature and in fact is a reflection of the feelings and assessments formulated by an individual in certain states. However, they have a significant impact on the actions taken in view of certain risks; actions whose task is the elimination or reduction of its harmfulness, when it occurs. T Kołodziński [10], referring to the

relationship between the seriousness of a real threat and its perception by an individual refers to Daniel Frei, who distinguished four possible security assessments:

- the condition of insecurity arises in a situation correctly perceived a real threat;
- the condition of obsession, which begins with a slight exaggeration of risk;
- the state of false security based on minimizing the perception of a serious threat;
- the feeling of security occurs when a threat is slight and correctly perceived.

S. Koziej [12] assumes that the threat has direct or indirect destructive impact on an entity. According to [11, 12], he distinguishes the following risks:

- potential and real;
- subjective and objective;
- internal and external;
- military and non-military, (*political, economical, social, informational, ecological, etc.*).
- crisis and war and
- intentional and accidental.

Considering the above, after T. Kołodziński [10], we assume that the “threat involves the sphere of awareness of an entity (an individual, social group, nation) and is a state of consciousness or the perception of phenomenon assessed as unfavourable or dangerous. Perception of threats by the entity, as well as his sense of security, is reflected in the awareness of a real or potential threat. What follows is that a perception may be incompatible with facts. Thus, assessing the security situation one should take into account the reality which includes threats to individuals or the society, and the state of their knowledge and awareness which involves perception of these threats and a sense of security”.

Safety is subjective and is a basic need for humans and social groups, and the state. Therefore, every human, social group and EU member states try to interact with their external environment and the internal sphere to remove or at least minimize a variety of potential and real threats generated by human environment. Principally, risks associated with different products (goods) introduced on the EU market will be referred to by the name of the ‘anthropogenic objects’. Such objects are deliberately created by the man in order to fulfil a variety of needs, both individual and collective.

The concept of an anthropogenic object

The subject of interest here are objects representing anthropogenic material goods, i.e. things (material objects, products, goods, objects) in technical and legal terms (art. 45 of the Civil Code). Material goods are items that represent the goal of human aspirations and are referred to as consumption material goods - because they fulfil the diverse needs of people. Additionally, material goods can be used in order to produce other material goods that may be, e.g. production goods. Material goods produced intentionally by humans are referred to as: products, goods, or objects. They can be mobile and immobile.

The subject of our interest is anthropogenic objects, i.e. material objects which are of a technical nature created by man. They are characterized by certain physical characteristics and

functional and utilitarian features tailored to meet specific human needs, including the need for security, which means that the objects satisfying certain needs must also be safe for humans.

Thus, it is assumed here that anthropogenic objects are technical objects deliberately created by men (such as machinery, equipment, building structures, etc.) or objects fulfilling various human needs, including the need for human safety. Creation of a technical object involves the following primary stages:

- the verbalization of the need to create an object (resulting from the necessity to meet specific human needs);
- the design of the object (requiring determination as to material and technical processes, which should be in accordance with applicable rules, regulations and principles of technical knowledge);
- production, intended for the manufacture of certain products designed to meet social needs. There can be many kinds (types, forms and varieties) of production: due to goals, complexity, size, scale, organization of work, the continuity of production, type of products and their varieties;
- distribution - includes all activities related to overcoming spatial, temporal, and quantitative differences between the place of production and the place of use (consumption);
- exploitation a technical object taken in relation to the manufactured object. The process of operation includes four basic types of activities: usage, handling, powering, and management;
- elimination of the object.

The process of using acquired goods (technical objects) in order to meet the needs, is called consumption. The entities for whom anthropogenic objects are made are referred to, in literature and regulations, as consumers, users, tenants, etc.

It is usually understood that the term "consumer" is based on the following criteria:

- subjective - defining it as a natural person and
- functional - defining consumption as unrelated to business or professional activity.

The above-mentioned definition of the "consumer" refers to the concept adopted in economics [21], where the consumer is defined as a user of purchased goods or services (consuming goods acquired in economic terms). The concept of consumer is defined in Directive 2011/83 / EU of 25 October, 2011 concerning consumer rights, Art. 22 (1) of the Civil Code and the law of 30 May, 2014 on consumer rights.

The concept of a consumer is directly related to the idea of consumer rights [24]. It is believed that consumers are weaker than market participants (i.e. they have less knowledge and are dependent on manufacturers to produce products, goods, etc.) who may influence consumers to make decisions contrary to their interests (e.g. to provide products of inferior quality, the use of misleading advertising, etc.). Therefore, legislation in many countries uses various methods of legal protection of these rights. In Poland, consumers' rights are protected by the provisions of Article. 76 of the Constitution, which states that: "Public authorities will protect consumers, users and lessees against activities threatening their health, privacy and safety and against unfair market practices" as well as the provisions of the Act of 30 May, 2014 on consumer rights.

The concept of safety engineering

By R. Zieba [23] and J. Ziarko [24] quote the most general definition of safety contained in the "Dictionary of the social sciences" by UNESCO. The definition included there, compiled by Daniel Lerner, provides that „in the most literal sense, security is virtually identical with certainty and indicates lack of physical danger or protection against it".

The concept of safety engineering of anthropogenic objects (to implement a variety of human needs) refers to practices (in technical, economic, legal and organizational terms) that occur in the process of design, construction and operation of anthropogenic facilities, which are aimed at ensuring the safety of these facilities through elimination or restriction of danger to an acceptable level or creating conditions to ensure effective protection [2, 3, 5].

Safety engineering deals with ensuring compliance with safety requirements, and performing risk analyses, i.e. identifying and preventing risk factors. These actions are performed appropriately to the type of object and the foreseeable risks that may occur during the expected existence of objects. Thus, its area of activity involves carrying out rescue and logistic operations, and controlling compliance with broadly defined security policies, conducting investigations into circumstances of breakdowns and accidents, and keeping records related to security.

Safety engineering of anthropogenic objects, such as machinery, equipment, industrial systems, and buildings concerns the determination and continuous improvement of practices and the knowledge of requirements and safety rules in the area of design, construction and operation of these facilities - appropriately to their purpose. It mainly involves the following skills:

- Identification of problems and tasks in the area of monitoring, decision-making, operation and diagnostics of the above mentioned facilities, and the management and engineering of operation of these facilities;
- Developing safety management strategies and actions to promote the reliability of facilities;
- Identification of the needs of the economic environment and implementation of innovative actions;
- Identification of threats to personal safety, communication technology and engineering research methodology.

General principles of safety engineering of anthropogenic object

The essence of the object of anthropogenic safety engineering is proceeding leading to the creation of a secure facility. To achieve this goal it is necessary to take action consisting in transmitting to the subject of such features, which will allow the [2, 3, 5]:

- eliminate or reduce risks to human size (up to the level of fishing) anticipated to occur during the lifetime of the object - the object generated from the (ob, h) under the influence of the functional-utility solutions and construction-material under the influence of an object and its environment interactions(ob, en) and

- eliminate or reduce the size of the risks to the environment of the object (to an acceptable level) anticipated to occur during the lifetime of the object - the generated in the object as a result of interactions with the environment (en, ob) under the influence of the functional-utility and construction-material solutions adopted in the object.

A schematic diagram of the conditions of anthropogenic safety engineering facility in its creation and operation illustrated in Fig. 1.

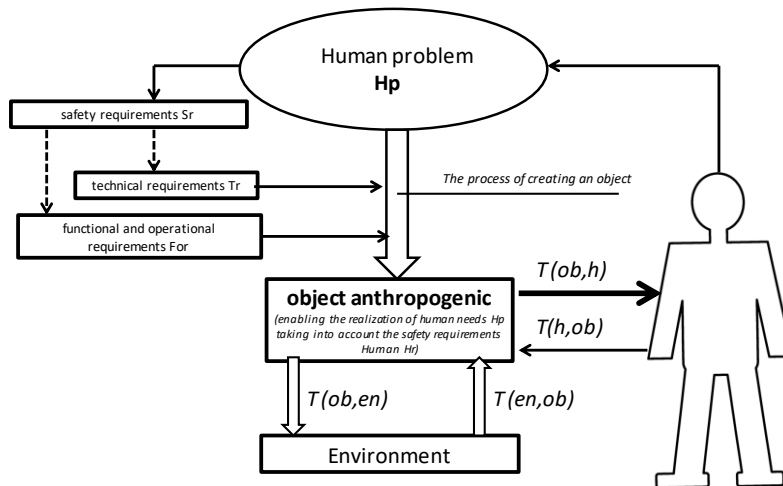


Fig. 1 A schematic diagram of the conditions of anthropogenic safety engineering object in its creation and operation.

$T(h,ob)$ – human threats originating in the anthropogenic object

$T(ob,h)$ – object anthropogenic threats of human origin,

$T(en, ob)$ – environmental risks derived from the anthropogenic object

$T(ob,en)$ – threats to an anthropogenic object originating in the environment,

The activities being the core of safety engineering will be called anthropogenic activities immunizing an object to certain threats [2, 3, 4, 5].

Timewise, these actions can be divided into two stages of immunization of a building:

- primary immunization - involving the immunization of the object at the time of its creation (at the stage of programming, design and implementation);
- secondary immunization - involving the immunization of an existing object.

Forms of immunising anthropogenic objects

Safety engineering of anthropogenic objects is related to materials engineering, environmental engineering, computer science, and mechanics in design processes, construction and operation of anthropogenic facilities. Immunization of anthropogenic objects, depending on the type of object can be carried out (as part of primary and secondary immunization) by the following activities [2,3,4,5]:

- spatial solutions;
- functional solutions;
- construction and material solutions;

- selection of installation and technical equipment;
- organizational solutions.

Most commonly, primary immunization costs of a specified object are smaller than the cost of immunization related with secondary immunization on an existing one.

Problems of modern technologies in support of the wider security systems

As pointed out by Z. Mierczyk [15], the issue of safety engineering research with relation to anthropogenic objects filling our environment is closely related to modern technologies detecting and forecasting the development of threats, IT processing, protection and risk prevention and liquidation of their consequences. Development of new technologies, supporting security systems (in the broad meaning of the term), is interdisciplinary and includes numerous fields of science, such as chemistry, materials science, mechanics, electronics, information technology, automation and robotics, telecommunications, environmental engineering.

The need for action in this field stems from the need of equipping state services ensuring security to citizens with specialized technical equipment and information systems to support monitoring, identifying and countering threats to the security of citizens, including decision-making processes, information, emergency and crisis management, and effective emergency management and crisis response activities . These technologies include the following areas [14]:

- Technical security is primarily concerned with the design, construction, operation and disposal of buildings and industrial and municipal infrastructure. This applies to virtually all fields of technology, such as nuclear energy, conventional energy, transport, industry, construction, etc. The main areas of interest of safety engineering in terms of technical safety include issues related to sensors, measuring devices and systems for monitoring the safety of anthropogenic objects and natural environment, and management automation in the event of risks (industrial accidents, natural disasters, terrorism).
- Civil Security focuses on matters of protection against the effects of various threats, determining the standard of living and health of the population.

Contemporary needs in the area of security require seamless cooperation between all state institutions, administration and government, and adaptation of their working methods to new threats, including the need to have at their disposal a modern, integrated crisis management systems [14].

Abstract

Safety engineering of anthropogenic object requires:

- Knowledge of interdisciplinary technical and specialist knowledge in the field of basic methods and tools used in solving engineering tasks related to general security of technical objects - in the process of design, construction and operation;
- Knowledge of modern technology and research instruments capable of detecting and forecasting the development of threats, IT processing, protection and risk prevention and liquidation of their consequences;
- Diagnostic skills with regard to threats to the safety of technical objects with the use of modern technology and research instruments;

- Knowledge of safety engineering principles adopted in the European Union and national legislations.

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