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Safety engineering of anthropogenic facilities in applied sciences

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Abstract

"Security" is an interdisciplinary concept and appears in various areas of life, science and knowledge describing the reality in which modern man lives, and its aspects are studied by many different scientific disciplines using engineering achievements. In simple terms, safety should be treated as the absence of threat throughout the entire life cycle of an anthropogenic object.

Help in eliminating or reducing threats can be provided by applied sciences, which are focused on transferring knowledge about the surrounding world, diagnosing and understanding phenomena, problems and social processes, and the combination of achievements in safety engineering and applied sciences can give satisfactory results.

The article proposes a model that takes into account safety engineering issues in the life cycle of an anthropogenic object using the achievements of applied sciences.

Keywords: safety engineering, anthropogenic facility, applied sciences

1 Introduction

The term „security" is derived from the Latin word sine cura = securitas (without fear, apprehension) and has evolved historically. It was colloquially understood as the absence of threats, while dictionary definitions tended to identify security with certainty, a state opposed to threats [24]. This meant that the term was treated as a synonym

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for the absence of threats, protection against threats and also as certainty resulting from the non-existence of threats and (or) effective measures to prevent or remove them [1,4,12,13,20,22,23] .

An analysis of the available literature makes it possible to conclude that ***"security"*** is an interdisciplinary concept and appears in various areas of life, science and knowledge describing the reality , in which people live, and many different scientific disciplines study aspects of it. These include history, psychology, sociology, legal science, political science, military science, civil engineering and many others [4,8,10,14,15,16,17,18,19,21,22,24] .

In the modern world, security is dealt with by the ***security sciences***, which belong to the ***social/applied*** sciences with practical applications [2,7].

The applied sciences are geared towards imparting knowledge about the surrounding world, diagnosing and understanding social phenomena, problems and processes, and developing the skills to acquire, collect, analyse this knowledge.

Helping to solve applied science problems can be ***'engineering'***.

Nowadays, the term 'engineering' describes a procedure in which the analysis of a selected fragment of reality is carried out comprehensively using a systems approach, and the proposed concepts and solutions are formulated from a systems perspective. According to T. Kasprowicz [9], the term "engineering" should be regarded as:

- an expanding branch of practical science that describes, investigates and formulates laws about a specific part of reality, including inorganic and organic matter, plants and animals;
- the decision-making process and use of resources subordinated to the objective of preparing and carrying out a project.

Engineering can take different forms depending on the areas involved (Table 1.)

Table .1. *Types of engineering*

Lp.	Name	Characteristics
1	Mechanical engineering	It includes, among other things, the design, manufacture, inspection and maintenance of equipment, machinery and components, as well as the systems and control instruments used to monitor their condition.
2	Structural engineering	It includes, among other things, the design, construction and inspection of load-bearing structures - bridges, buildings or industrial infrastructure.
3	Industrial engineering	It includes the design and optimisation of production equipment, systems and processes, as well as the processing of materials and other working environments.
4	Computer engineering	Includes design of computer hardware components, computer software, computer systems and networks.
5	Environmental engineering	It includes engineering projects aimed at maintaining the natural environment in a state of equilibrium and preserving its capacity for self-regeneration and self-purification, and, in the event of environmental devastation (e.g. as a result of disasters, over-intensive economic activities, accidents), aiming to restore this equilibrium.
6	Chemical engineering	Includes combining and processing chemicals to produce high-value products, and designing equipment, systems and processes for refining raw materials.
7	Biomedical engineering	Includes the design of equipment and systems used in medical practice.
8	Nuclear engineering	Includes the design, construction, operation and testing of equipment, systems and processes (e.g. for electrical power plants) related to the production, control and detection of nuclear radiation.
9	Aeronautical engineering	It covers the design, manufacture and testing of spacecraft and aircraft, as well as their parts and components.

10	Civil engineering	A discipline of engineering and technical sciences that shapes the earth's surface for human existence. It combines skills such as the analysis, design, erection and maintenance of all building structures
11	Occupational safety engineering	A field of engineering science , which provides knowledge and skills in the analysis of safety and occupational risks and the design and monitoring of technical working conditions.
12	Electrical engineering	A field that deals with issues related to the generation, storage, conversion, transmission and use of electrical energy. An electrical engineer must have a comprehensive knowledge of physics (in particular, areas such as electricity, electrodynamics and electric current), mathematics, power engineering, mechanical and materials engineering, electronics, computer science and automation.
13	Mechanical engineering	All knowledge relating to the design, manufacture and operation of machines and structures, excluding electrical and power machines, which are the domain of electrical engineering and power engineering, and mathematical machines, which are the domain of computer engineering.

In doing so, it is important to remember that in each case ***'safety'*** must be ensured, which is an interdisciplinary concept, as each field of science or practice deals with different aspects of safety according to the type and anticipated risks that may occur during the life cycle of the facility.

2 Life cycle of an anthropogenic site

Anthropogenic objects are technical objects intentionally created directly or indirectly by man (machinery, equipment, construction objects, etc.) intended to satisfy his various needs, including the need for safety. In engineering terms [6], it is assumed that there are five basic phases associated with a technical object: formulation of the need to create the object, design, production, operation and decommissioning, which form the life cycle of an anthropogenic object (Fig.1). The determinants of safety engineering in the life cycle of anthropogenic facilities are shown in Fig. 2.

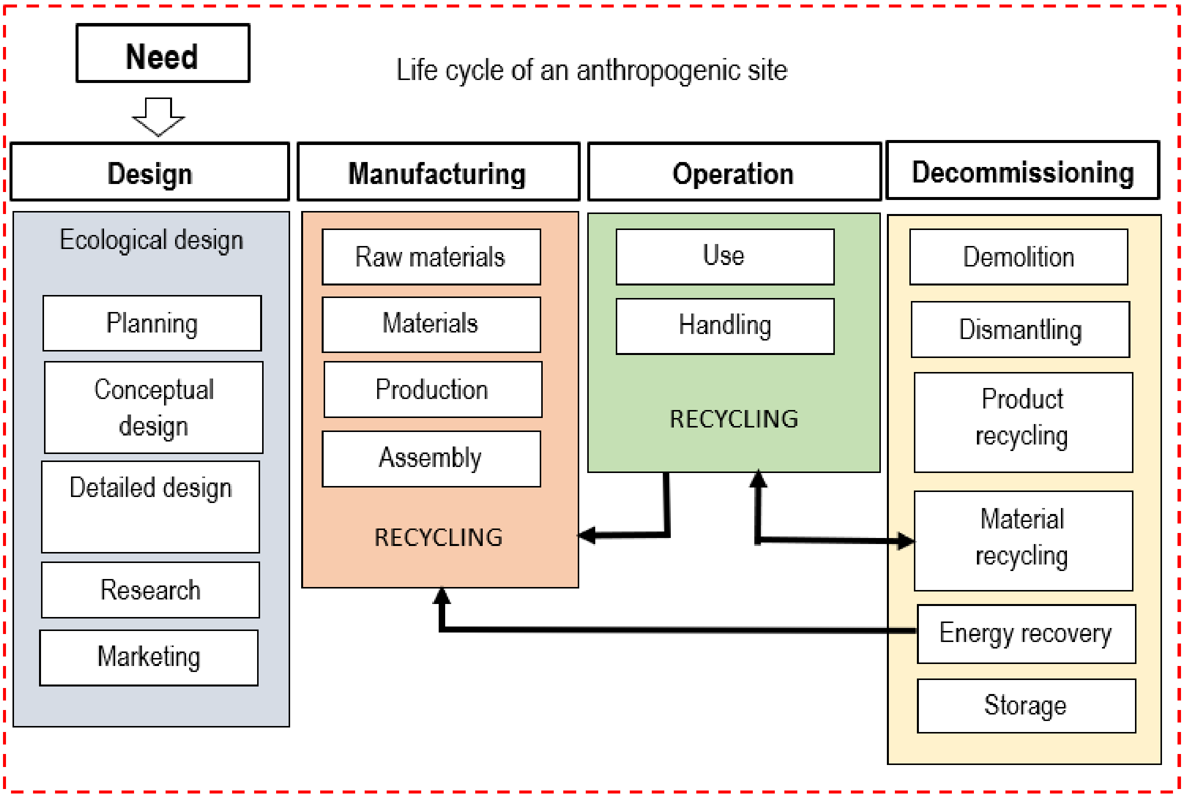

Fig.1. *Life cycle of an anthropogenic site*

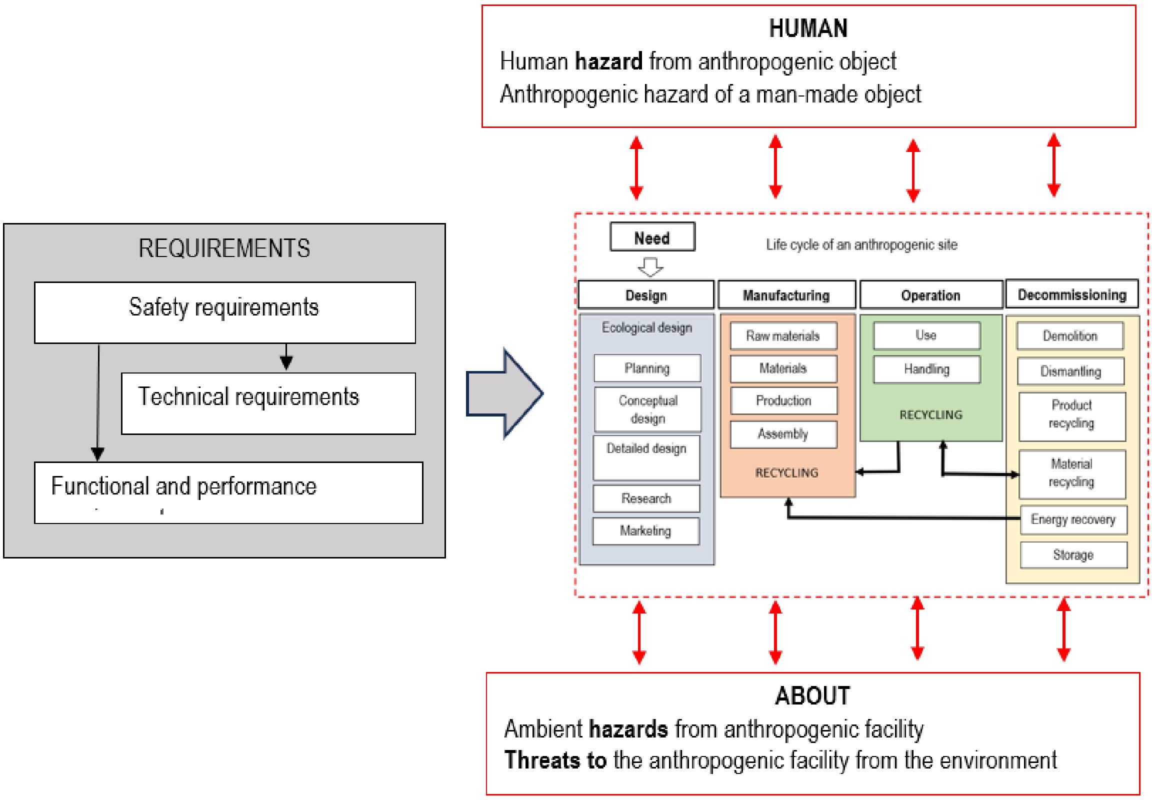

Fig.2. *Idealized diagram of safety engineering considerations in the life cycle of an anthropogenic facility - own elaboration based on [6].*

To summarise the theoretical considerations of security in the life of an anthropogenic object, it is reasonable to consider security in two areas: subjective and objective - depending on where the threats are located [11]. This is due to the functioning of each anthropogenic object in a specific environment, which is conventional for each object, and to the fact that each anthropogenic object can cause different (subjective) risks for each person.

Depending on who/what they affect, where they are located and where the threats originate from, a distinction can be made:

- Entity security: external, internal, which means the absence of threat from the entity using the anthropogenic object (internal) or the absence of threat from other entities in the environment (external);
- subject safety: external, internal, means the absence of danger to other objects from the anthropogenic object (internal) or the absence of danger to the anthropogenic object from other surrounding objects (external).

By combining the internal and external aspects of safety, one obtains a holistic view of the safety of an anthropogenic object in the systemic view of engineering, which includes activities that make it possible to satisfy the various human needs concerning the technical, economic, legal and organisational approaches occurring in the processes of designing, constructing and operating objects aimed at ensuring their safety by eliminating/reducing the hazard to an acceptable level or creating conditions that ensure effective protection against them [2,3,5].

3 Summary

The development of civilisation brings with it many threats and, consequently, a loss of security in the broadest sense. Help in eliminating threats may be provided by applied sciences, which gather knowledge allowing to solve specific real-life problems and to use the achievements of the developing safety engineering, which grew out of the problems connected with the necessity of counteracting the threat to mankind and the whole natural environment as well as the goods of civilisation by catastrophes of technical objects from all areas of technology (construction, industry, transport, mining, armaments industry, etc.), natural phenomena (earthquakes, hurricanes, avalanches, floods, etc.) and deliberate acts of God.), natural phenomena (earthquakes, hurricanes, avalanches, floods, etc.) and deliberate destructive actions and lack of knowledge of the risks caused by anthropogenic objects.

Safety engineering of anthropogenic sites in applied science requires:

- interdisciplinary, general technical and specialised knowledge of the basic methods and tools used in solving engineering tasks related to the broadly understood safety of anthropogenic facilities - in the processes of their design, manufacture, operation and decommissioning;
- knowledge of modern technologies and research tools for detecting and forecasting the development of threats, ICT information processing, protection and prevention of threats and elimination of their consequences throughout the life cycle of an anthropogenic site;
- the ability to diagnose the hazard status of anthropogenic sites using modern technologies and research tools;
- knowledge of the principles of safety engineering adopted in European and national legislation.

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