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# THEORETICAL AND METHODOLOGICAL BASES OF THREATS. THE METHOD OF SECURITY MANAGEMENT SUPPORT

A new approach to threat analysis and management of security understood has been presented. Threats have been analyzed in a wide theoretical-methodological range with particular emphasis on the need for the system-wide analysis of threats in terms of social (sociological), psychological (psychology of the crowd) and religious aspects. A method supporting security management has been proposed, using two-person zero-sum games to model situations of conflict. The matrix, infinite, logical and topological forms of such games are considered.

Keywords: *management, security, threat, conflict, game theory*

## 1. Theoretical and methodological approach to threats

Considerations on the training of university graduates, in particular in the field of National Security, for their professional life have been presented, those involved in shaping the programs of studies and analysis of security understood in a wide sense[4].

The modern world exhibits globalization in the generally positive aspect of the meaning of this concept[5]. On one hand, the liberation of particular societies can be

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[4] This applies, in particular, to studies if the field of National Security.

[5] It is noted that the “mighty” of the world tend to unify in a manner convenient for them, i.e. to rule (but not manage) over the world according to the standards set by themselves – to give to one seen as

noted, especially those that have existed for centuries in a social system imposed on them somehow from above, in some way (Arab countries, societies of South America, Asian countries) via political, social, religious, moral and other means such as subordination by foreign influences which occurred during different types of processes that took place in the long history of these countries.

However, on the other hand, the Renaissance Era, Enlightenment and subsequently Positivism born in Europe as a result of the dominance of Christian culture and faith[6], contributed to the development of Science. The establishment of the first universities gave the Europeans the opportunity of independent thinking. Scientific thought has evolved into a form of material (and also spiritual) realization. At first, there arose workshops employing people – professionals producing goods, later manufacturing (quasi-factories) until, at the end, factories with mass production capabilities came into existence. Hence, *capitalism* was born, a new form of the exploitation of man by man on an unprecedented scale. On the other hand, capitalism has enabled people (ironically) to become more free and independent, as a result not just of the income obtained but mainly because of the development of new professions. As a result of a new potential for production, individuals could set up their own workshops and even small factories. This has all raised the need for new forms of social organization, especially in terms of the management of specialized, in the sense of professional, society (defense against the exploitation of working men, and on the other hand the organization of nurseries, kindergartens, housing and other facilities leading to a more comfortable life by employers themselves). The dynamic development of production, new forms of urbanization (e.g. around production plants), gave rise to other threats – more massive and dangerous than before, especially when unrecognized.

Each new form of organization involves a different style of management from the previous one. Any new system (system structure) has a different *variety* (complexity) and it is necessary to describe it anew, that is, to use the language of systems theory. It

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*good* but take away from another seen to be *naughty*. This is a negative dimension of globalization but they try to convince the World that this is the best choice for it. However, computerization, the Internet, newspapers (especially those *positive* independent papers but even those negative, which are at the service of the *mighty*, e.g. colonizers) are dangerous elements because they are able to convey to the general public information discrediting negative intentions to subjugate poor societies, those worse educated, and even expose governments involved in shady deals and the speculations of these rulers.

[6]Christianity, not just as a religion but also as a European cultural pattern, contributed to the emergence of democracy, firstly, in some European countries, and then spreading not just over the whole continent but the civilized world. Although we talk about Greek or Roman democracy (the concept of a republic, they were democracies for selected classes of society, not for society as a whole. In the 18th century, Poland was the first country in Europe to introduce the equality of all its citizens under the law (except for serfs) as a result of the adoption of the May 3rd Constitution,. The previously privileged society classes voluntarily renounced their privileges in favor of equal rights for all citizens.

needs to be identified, recognized and, above all, its behavior and performance have to be understood [3, 4].

However, the *system paradigm* itself also relies on a new way of thinking in relation to the previous one. What is this new concept of thinking about? Before systems theory was developed in the twenties of the last century, so-called *structuralism* was born in the linguistic field (the system paradigm has its roots in structuralism) – a discipline which demanded the need to determine the structure of an object (a system). The associated mathematics and logic developed at that time could express (represent) such structures formally. Among other things, *generative grammars* were a manifestation of this, which generally originated from linguistics (a combinatorial system) [2, 5].

*Generativity* is a concept that intuitively can be expressed as follows: duplicate the pattern in a new dimension but keep its previous character.

How does all this relate to the problems of security and its management? To answer this question sensibly, and – above all – pragmatically, it is necessary to ask, what new has systems theory brought to the world of science[7]? This new scientific thought posed the following question to scholars in relation to the structure of the system being investigated (the concept of structuralism):

What is the structure of the system being investigated and why it is like that, or how does the system behave (act, e.g. in the social or individual-psychological dimension) and most importantly, why does it behave this way and not otherwise? This is, generally speaking, the essence of the system approach, which is the essence of the scientific paradigm. Before the rise of structuralism and system analysis, the approach of collection, bringing facts together[8], dominated broadly in science.

The modern world and *Nature* itself [9], is highly organized and also very complicated. On one hand, such a system is *difficult* to manage but at the same time, it is *quite easy* to disrupt, due to the potential of information technology, the media and achievements of technology available to modern man, as mentioned above[9]. It is also impossible to quickly and easily correct false – wrong information in the state of such a system, especially in terms of time (this can refer to a variety of false news, TV information, stock market news, political, etc.). Psychology knows some scientific facts concerning so-called *crowd psychology*[10], i.e. the general behavior of society in the situation when a certain piece of information is given (which has

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[7]The creator of the systems theory, as is now known, was L. von Bertalanfy, an Austrian scholar but the Russian scholar (of Polish origin), Aleksandr Bogdanov [6], is considered to have laid many of the foundations for this theory.

[8]As far back as the 4th century BC, Aristotle stated that there is *no science about one dog*. Therefore, it is a practice of science to approach things in overall terms (global).

[9]Today, if the electricity and water supply to a big city is turned off for a longer period of time, then human activity in it is paralyzed. Therefore, the behavior of a *city* as a system is highly sensitive to just a few important variables.

[10]A German psychologist W. Wundt is considered to be a leading light in this field of psychology.

a significant meaning, regardless of whether it is true or not). The consequences of such information cannot be determined or predicted (recognized, measured; e.g. the economic crisis of the late twenties and thirties of the last century in the United States) even by mathematics. This all has measurable (in the sense of being significant) effect and impact on the public understanding of the safety – durability of an analyzed system.

But every system, as it has been emphasized, has its own certain structure, that is, its *durability* and that structure is so designed that it has so called *stability*, that is behavior which is robust to changes in factors influencing the system. In formal terms, one can talk about the equilibrium state of a system. Such an equilibrium state guarantees the existence of the system and that no drastic (social, economic, psychological and other) changes occur when there are moderate alterations in the factors affecting the system [10, 11]. The degree of stability of a system may be interpreted as how safe it is. But the structure of a system, and on the other hand, factors leading to its disturbance can be interpreted in the form of *a game*, *a zero-sum game – what one party loses*, *the other gains* [7].

*Security management requires a system-wide approach which is comprehensive in attaining and maintaining the system equilibrium. Such a property requires skillful management* (*research, monitoring, observing, fact gathering, establishing the ways in which such an equilibrium state can be disrupted*).

Such multi-dimensional management is guaranteed by the well-established position of informatics in modern science and the methods applied to transmit information to its users have created a completely new concept, known as *cyberspace*. Cyberspace has the property that if any information is placed there, then it is made available to all its customers. This is very important for security management, particularly when it is threatened by terrorism (cyber terrorism). Any information regarding a danger is available in this space to all. Information technology allows people to integrate, i.e. makes them an *information society*. One can imagine that the twenty first century will be a period of creating a *knowledge society*, since information becomes knowledge when it is verified, i.e. is shown to be fact. However, the verification of information must be carried out quickly in order for it to be effective as the truth. The information technologies used today already go a long way to achieving this goal.

*Knowledge determines the truth, and yet it is the negation of falsehood, in other words, of an evil in the human dimension. Terrorism is such an evil. Knowledge about it aids in restricting the use of it.*

The above sentence recognizes information and the truth only from their pragmatic side but overall it is still an unsolved problem in science: how to get knowledge from information in the form of truth? The pragmatic dimension mentioned above refers mainly to following question: how can the safety of a system, i.e. its equilibrium, be ensured in situations corresponding to two player games, where one player might be:

- state,
- national economy,
- health system,
- education system,
- sport,
- culture of a country,
- welfare and other areas of the life of a whole society or given nation.

Who is one player, and who is the second? One of the players is a given system (for example, one of the above reference areas) and the other is someone who wants to disrupt or even destroy it.

However, such a game can also be put into a different dimension, for example, in relation to the concept of *the State*, in terms of the government, parliament and president – as the first player ($G_1$) and society in terms of citizens – as the second player ($G_2$).

Another view results from considering the relationship between the *Authorities and the Media* (the 4th power). Such formulations, however, should be considered as cooperative games because all sides have the good of the same object – the *country* as a whole – in mind. But, as already mentioned, there may be a player who wants to disrupt the given area (system). Such a player may be:

- a terrorist organization (the most dangerous type of a player),
- a competitor (another country competing, e.g. for markets),
- a political opponent with a different vision of the state, etc.

## 1.1. Teaching and education system

There are colleges and universities that educate students on a variety of professions necessary for the proper functioning of a country. For example, the following two courses of education are particularly important in the context of the problems discussed:

- management,
- security.

They play an important educational role in the overall safe functioning of the state.

*Therefore, the combination of these two substantive fields of education will create a new quality in the education system related to students interested in learning new advanced knowledge in the area of state security management.*

This requires a system approach from specialists in the area of management, computer science, mathematics, psychology, sociology and the military, in relation to training related to the prevention of threats, associated with security in a wide sense.

### 1.2. Main aspects of education

Some classical subjects have an important meaning for education in issues related to security and management. For example, such subjects as:

*Management*: classically lectures the fundamentals of management common to all directions of education but should be updated with content on its security dimension (clearly and fully expressing the role of management in teaching security).

*Information technology*: provides basic tools but should also explain how to implement these tools, ways of utilizing data in managing the security of a given system – information technology in the service of security management.

To lecture the basic mathematical tools needed in management but support these by examples, for such an approach is not a mere abstraction. To emphasize the important role of statistics (data collection and their statistical analysis for the purposes of security).

*Psychology*: to lecture the essence of human behavior as described by this science but give examples of human behavior that are based on the deformation of social structures and what kind of human characteristics are significant in determining such behavior, and most importantly, how to identify them from the psychological point of view and which are important from the wider point of view of the security of the state.

*Sociology*: to lecture the principles governing the structure of societies but to point out the factors causing their deformation (the social dimension of the organization of societies, groups, regions and clans).

*Army*: to present the essence of the organization of the army and its management (as a guarantor of state stability) but also to demonstrate its strength, which can threaten the safety of the state in the absence of control.

It is also necessary to remember other services related to state security, which include in particular: the police, fire service and prison service. Thus, an attempt can now be made to identify the most important categories of threats that should be included in the education system.

### 1.3. Structure of threats

Areas of threats associated with a wider understanding of security concerning the state, society, education system, culture, ecology, economy, health, social norms (religion, ethics, education) and prosperity can be specified in a different way, i.e. analyzed from various points of view. Threats can be seen as:

The sphere of civilization threatened:

- political,
- social,
- health,

- economic,
- ecological,
- public order and security,
- demographic,
- communication,
- information (media, propaganda, etc.),
- education,
- other.

Categories of threats
- natural,
- cultural,
- psychological and social,
- political,
- technical and informational,
- others.

The range of threats
- global,
- continental,
- regional.

The source of threats
- natural,
- economic,
- social,
- political,
- other.

Criteria for classifying threats
- ecological,
- political,
- economic,
- social,
- military – army,
- other.

In general, the above description of threats can be summed up in the diagram shown in Fig. 1[11].

With respect to each of the areas listed in Fig. 1, there are specialists able to describe such problems. It is intended that this subject of threats could be presented to students in facultative classes and not necessarily in the range of programmed hours,

[11]These categories and types of threats can be interpreted in each of the three dimensions described in the diagram.

and moreover by placing emphasis on the management of threats, that is how to recognize and counteract them. For example, there could be a (single) lecture on the threats faced by large urban agglomerations, as seen from the point of view of microbiology (bacteria, contamination of water from terrorists and other such kinds of dangers).

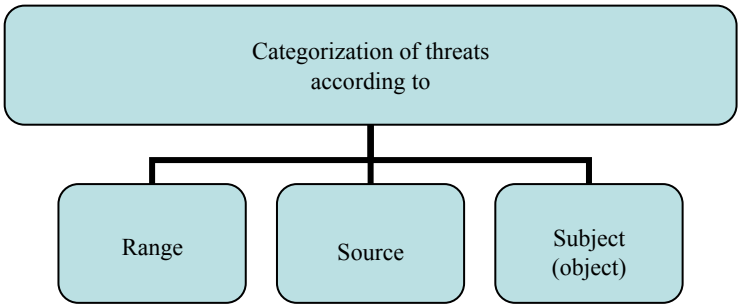


Fig. 1. Dimensions of threats

## 2. The method of security management support

Highly organized (democratic) societies are more susceptible to the actions of terrorist groups in them than communities in generally totalitarian or quasi-democratic regimes (the evil uses the good according to the old well-known principle). Democracies are susceptible to terrorism but have a stable way of functioning. People might compromise themselves but not the system as a whole. The system maintains its *equilibrium state*; attacks on the order of a system do not destroy it; states of the system have the following *self-similarity* property, i.e. the next state generated is similar to previous ones. The basis for stability is created by *the political opposition*, generally by a control system. Objectively, the *media* should be a higher level control system over the governing party, opposition and terrorists. But who is to control them? They themselves certainly are not, so who is? This is an important aspect of the safe operation of a given state. There are services that directly protect state security but the question raised above also concerns them, i.e. who is to control them? At this point, there emerges the problem of developing a (democratic) system of control over any system, especially over a party who has power (for example, the media are the fourth power), on the other hand, who is to "control" terrorists because after all they benefit from the achievements of democracy. To answer this question in a meaningful way, there should be a well-organized education system including staff responsible for the fight against terrorism. It should also be emphasized that this question is not paradoxical

because from not too distant history, we know that sometimes people associated with terrorists or the mafia held high state offices, including the presidency.

## 2.1. Theoretical basis of the approach

The set of pure strategies of a player are given by a list of threats to which a given system may be vulnerable. Player $G_1$ represents a state, while player $G_2$ represents a player posing a threat to the state.

We need to define the payoffs obtained by player $G_2$ when a given pair of pure strategies is followed because having these payoffs, one can solve any game. These can be zeros and ones, i.e. 0 – the threat is (threats are) counteracted, 1 – the threat is (threats are) not counteracted. If there is more than one threat corresponding to a given cell, then we may enter that number into that cell. Also, the use of positive and negative numbers can be considered. There are many possibilities, and the particular form of a game used (the payoff matrix) depends on a practical analysis of the problem under consideration.

The solution of such a game will give overall insight, including weights (probabilities) ascribed to the particular categories of threats, and will enable working out education programs appropriate to the analyzed task and the solution of the game, i.e. placing the required stress on important and less important subjects, both in relation to the security issues considered here and their efficient management.

Two examples of payoff matrices will be analyzed. For the former one, we will provide its derivation, for the latter we will just give the payoff matrix.

Let us take into account threats which are just dependent on their scope, i.e. at the most general level: *global*, *continental and regional*. Appropriate weights should be assigned to them. We have three categories. The most important are global threats, then continental, and finally regional. What weights should be given to them? This problem is relatively simple: the weights should be natural, that is, the measures of their importance. For example, the following weights can be ascribed to them:

3:2:1

The total sum of these weights is 6. This sum will be the basis for constructing the payoff matrix for our game.

We now form the payoff matrix. Player $G_1$ is an education system, and the second player, that is $G_2$, represents an organization posing a threat. The strategies of player $G_1$ refer here to the subjects taught in terms of these threats. Thus, there will be three categories of subjects, i.e. those that discuss global, continental and regional threats, respectively. We need to create the 3×3 payoff matrix and solve the game, in order to

answer the question of the importance of subjects with respect to the threats taken into account.

It remains now to build the payoff matrix which takes into account the given weights. We can use Fig. 2 as a graphical illustration of the problem analyzed with regard to the accepted weights of the threats.

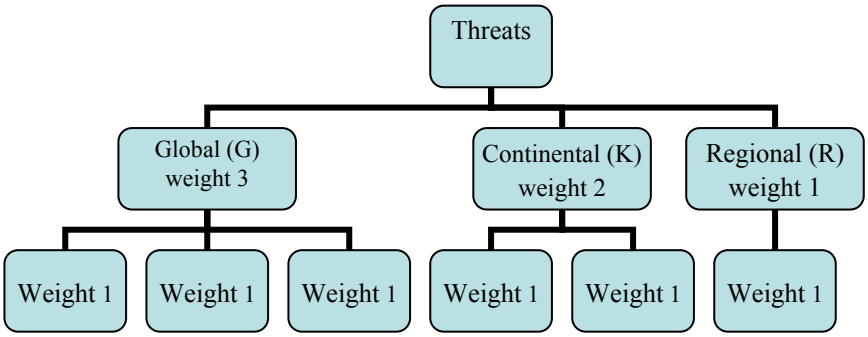


Fig. 2. Graphical illustration of *weights* in relation to the categories of threat

Figure 2 integrates the categories of threats and their weights. The payoff matrix used is:

$$\mathbf{M} = \begin{bmatrix} 6 & 4 & 5 \\ 3 & 6 & 5 \\ 3 & 4 & 6 \end{bmatrix}$$

The matrix was obtained in the following way. For example, in the first row and the first column we have the number 6 as the payoff to player $G_1$ when emphasis is placed on subjects related to global threats, and when such a threat occurs. However, as a result of education we can counteract it, so we do not lose anything from the sum of six points. The payoff in the third row and second column takes the value of 4 because issues concerning regional threats are discussed but a continental threat has occurred – which we cannot counteract. Therefore, from the available number of six points, we lose two. The other entries in the payoff matrix are derived in a similar way. This game is very easy to solve. Moreover, it is an open game, which has no saddle point. Appropriate weights should be ascribed to each category of threat, and thus, appropriate to these weights, specialists able to predict, recognize and suitably counteract such threats should be employed[12]. It needs to be noted at this point, that

[12]These considerations should be applied, in principle, only to human activity. They should not be associated with the behavior of nature but even in this dimension, to some extent, this analysis makes

the previously mentioned methods of statistical analysis may be very useful research tools in achieving this goal, in particular, forecasting methods, multidimensional analysis, or methods and tools for the construction of econometric models. Statistics based on collected, i.e. real data, is in a position where it can assess the likelihood and weight of various categories of threats[13].

The game presented above has the following solution: the value of the game is

$$V = \frac{25}{5}$$

and the equilibrium (minimax) strategy for player $G_1$ is given by

$$(x_1, x_2, x_3) = \left(\frac{3}{5}, \frac{2}{5}, 0\right)$$

where $x_i$ is the weight ascribed to the $i$-th category of threat by player $G_1$. For the second player, the equilibrium strategy is given by

$$(y_1, y_2, y_3) = \left(\frac{2}{5}, \frac{3}{5}, 0\right)$$

where $y_i$ is the weight ascribed to the $i$-th category of threat by player $G_2$. It can be seen that this game can be reduced to one with the payoff matrix

$$\mathbf{M}_1 = \begin{bmatrix} 6 & 4 \\ 3 & 6 \end{bmatrix}$$

It can be seen from the equilibrium strategies that the greatest weight should be applied to education on the global dimension. Indeed, this is a natural thing but the analysis of this question from the formal side, in this case – using game theory, shows this fact explicitly. It can be seen that education on regional threats is not so important.

This analysis makes the assumption that we are dealing with rationally behaving players. Potential threats may also be treated as appearing as a result of the actions of nature. We now have to deal with the category of games called *games against nature*. Such games should be solved in a different way than previously. Two cases should be

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sense because Man has learned to predict, e.g. weather, and thus is able, to some extent, to defend himself against its effects at each level: Global, Continental or Regional.

[13]It should be emphasized and remembered that, generally speaking, *quantitative methods* are only support tools for the important qualitative issues analyzed here but on the other hand statistical data in relation to existing threats can only be analyzed correctly using mathematical statistics. This is the logical premise for the need to lecture statistics to those studying any course on national security.

considered. One of them is that we are given probabilities for the states of nature. We assume that there are three types of threat, denoted by *G*, *K* and *R*. The probability of the appearance of these three types of threat are given by $P(G) = 1/6$, $P(K) = 2/6$, $P(R) = 3/6$. In addition, we consider the following payoff matrix:

$$\mathbf{M}_2 = \begin{bmatrix} 6 & 2 & 1 \\ 2 & 6 & 5 \\ 3 & 4 & 6 \end{bmatrix}.$$

Calculating the expected payoff for responding to each threat in turn, we have:

$$\begin{aligned} E(G) &= 6\times\frac{1}{6} + 2\times\frac{2}{6} + 1\times\frac{3}{6} = \frac{13}{6} \\ E(K) &= 2\times\frac{1}{6} + 6\times\frac{2}{6} + 5\times\frac{3}{6} = \frac{29}{6} \\ E(R) &= 3\times\frac{1}{6} + 4\times\frac{2}{6} + 6\times\frac{3}{6} = \frac{29}{6} \end{aligned}$$

The above calculation can be also represented by the decision tree presented in Fig. 3.

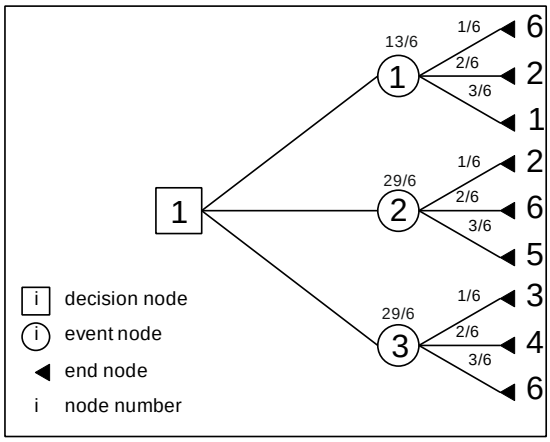


Fig. 3. Decision tree illustrating the interpretation of matrix $\mathbf{M}_2$

This indicates a greater weight attached to the threats *K* and *R*, due to their higher frequency of occurrence [1]. For the second option, that is, when the probabilities of the occurrence of the states of nature are unknown, the concepts of a *minimax* strategy or *Savage's criterion* are often applied to solve such a game. Instead of threats, one

can talk about the states of nature $W_1$, $W_2$, $W_3$, which correspond to the threats $G$, $K$ and $R$, respectively. For this game, the payoffs are shown in Table 1.

Table 1. An example of a game with nature

| $G_1$ | Nature | | | |
|---|---|---|---|---|
| | $W_1$ | $W_2$ | $W_3$ | Min. |
| $G$ | 6 | 2 | 1 | 1 |
| $K$ | 2 | 6 | 5 | 2 |
| $R$ | 3 | 4 | 6 | 3 |

Using the *minimax* approach, i.e. assuming player $G_1$ should maximize his minimum possible reward and analyzing the payments listed in Table 1, it can be seen that player $G_1$ should choose the strategy $R$ because from the minimum possible payoff obtained is 3 (as opposed to 2 or 1 when he chooses the strategies $K$ or $G$, respectively). Therefore, by choosing this strategy, player $G_1$ bears the lowest risk in terms of the minimum possible payoff.

Now we apply Savage's criterion which is based on minimizing the maximum possible regret that a player feels after observing the state of nature. This regret is defined to be the difference between the optimal payoff a player could obtain by knowing the state of nature (the maximum payoff in a column) and the payoff actually obtained. The maximum value in each column is 6, thus subtracting the actual payoff from 6, we obtain the following regret matrix (Table 2):

Table 2. The matrix of the risk of losses

| $G_1$ | Nature | | |
|---|---|---|---|
| | $W_1$ | $W_2$ | $W_3$ |
| $G$ | 0 | 4 | 5 |
| $K$ | 4 | 0 | 1 |
| $R$ | 3 | 2 | 0 |

Hence, the maximum regret possible when player $G_1$ uses strategies $G$, $K$ and $R$ is 5, 4 and 3, respectively. Hence, according to the Savage criterion, player $G_1$ should protect himself against the threat $R$, which is in line with the analysis carried out above.

## 2.2. Representation of threats in the form of an infinite game

It is possible to analyze the problem of threat prevention from a more general point of view. Namely, it can be treated as *a continuous infinite game*, because threats can potentially occur at any place and time, in each category considered by us here. We represent such a game in the form of a function of several variables taking values

from the interval [0, 1], corresponding to the particular strategies of (weights ascribed to each type of threat by) both players in the game. Denoting the strategy vector of player $G_1$ by $(1-x-y, y, x)$, and of the second player by $(1-r-s, s, r)$, we obtain the following table of payments and strategies (Table 3):

Table 3. Table of payoffs and strategies for infinite game

| $G_1$ | $G_2$ | | |
|---|---|---|---|
| | $1-r-s$ | $s$ | $r$ |
| $1-x-y$ | 6 | 2 | 1 |
| $y$ | 2 | 6 | 5 |
| $x$ | 3 | 4 | 6 |

We thus obtain the following so called utility function, whose arguments are the variables corresponding to the strategies of the players and whose coefficients depend on the payoffs:

$$U(y, x, s, r) = U(1-x-y, y, x, 1-r-s, s, r)$$
$$= 6 + x(8r + 5s - 3) + 4y(2r + 2s - 1) - (5r + 4s)$$

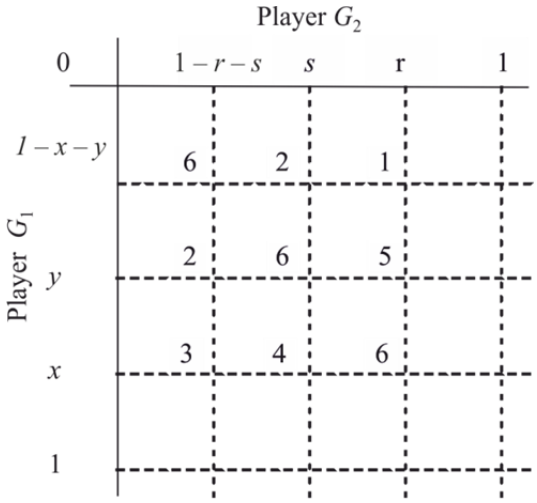


Fig. 4. Graphical illustration of a two player zero-sum game as an infinite game

It is easy to check that, for example, $U(0, 0, 0, 0) = U(1, 0, 0, 1, 0, 0) = 6$, which is the value in the first row and the first column of the payoff matrix. We can obtain all the other payoffs obtained using pure strategies, i.e. the values in the payoff matrix,

from this utility function[14]. Given any two vectors representing mixed strategies, we obtain the appropriate payoff by applying the function $U$[15]. There are infinitely many such pairs and they form a continuum.

The game as an infinite game with a continuum of strategies available to each player is represented by the following figure (Fig. 4).

## 2.3. Logical representation of the game

From the considerations made above, if the players choose pure strategies, i.e. a given action is always *chosen* (value 0) or is *never chosen* (value 1), then a logical variable can be assigned to each of the variables. The solution of such a game can be presented in the framework of logic, i.e. in a very general dimension. This indicates the logical structure of any zero-sum game. This procedure leads, in a certain sense, to a universal formulation of problems representing pure conflict. Let, therefore, the choice of strategy of the first player be represented by the logical variables $p_1, p_2$ and $p_3$ and of the second player, respectively, be represented by the variables $q_1$, $q_2$ and $q_3$. The logical form of the game is presented in Table 4.

Table 4. The logical representation of the game

| $G_1$ | $G_2$ | | |
|---|---|---|---|
| | $q_1$ | $q_2$ | $q_3$ |
| $p_1$ | 6 | 2 | 1 |
| $p_2$ | 2 | 6 | 5 |
| $p_3$ | 3 | 4 | 6 |

A logical expression representing this game is as follows:

$$\alpha = \left\{\left[p_1 \wedge \left(q_1 \vee q_2 \vee q_3\right)\right] \vee \left[p_2 \wedge \left(q_1 \vee q_2 \vee q_3\right)\right] \vee \left[p_3 \wedge \left(q_1 \vee q_2 \vee q_3\right)\right]\right\}$$

Let

$$\beta = \left(q_1 \vee q_2 \vee q_3\right)$$

then

$$\alpha = \left[\left(p_1 \wedge \beta\right) \vee \left(p_2 \wedge \beta\right) \vee \left(p_3 \wedge \beta\right)\right] \equiv \left[\left(p_1 \vee p_2 \vee p_3\right) \wedge \beta\right]$$

[14]Ones in the vector of variables ($i - x - y$, $y$, $x$, $i - r - s$, $s$, $r$) indicate which pure strategy pair is used in a given round of the game.

[15]Values different from zero and one represent the frequency with which an action corresponding to a pure strategy is used. In a particular round, the players always chose an action corresponding to one of their pure strategies.

Hence, we obtain a logical expression of the following form:

$$\alpha = \left[ \left( p_1 \vee p_2 \vee p_3 \right) \wedge \left( q_1 \vee q_2 \vee q_3 \right) \right]$$

The expression $\alpha$ corresponds to the well-known normal conjunctionally-alternative figure in classical logic. However, it is not a tautology, which is quite normal because the players only play the game from time to time. However, when the game is played, then $\alpha$ takes the value of one, as exactly one of the variables $p_i$ ($i$ = 1, 2, 3) takes the value one, as is the case with the variables $q_i$ ($i$ = 1, 2, 3). Hence, we deal with excluding alternatives.

### 2.4. General interpretation of threats

The threats analyzed here are by nature generally associated with conflict situations, such as *something threatening something or someone* and that is why they can be interpreted as zero-sum games. However, zero-sum games can be formulated in various ways, such as: matrix, infinite or logical form. This then raises the problem of unifying this theory because only one reality can exist. It seems that all these aspects can be interpreted in one dimension, and this dimension can be interpreted as the topological form of the game. Choosing a strategy refers to the set (interval) $I$ = [0, 1]. If the players use pure strategies, then they select from the set of boundary values of $I$. These values in the topological sense [8] are denoted by Fr($I$) and in this case we are dealing with a game matrix (a one-play game). If, however, a strategy is represented by a value from the interior of the set $I$, i.e. Int($I$), then the game can be regarded infinite[16].

## 3. Conclusions

Security management understood as an important aspect of human life is associated with decisions, appropriate to a given security area, taken both in terms of the type of threat, i.e. from the recognition side and also in terms of counteracting such threats. This requires preparing a list of the most important factors influencing the types and areas of threats, as mentioned in this paper. Therefore, there is a need for comprehensive interdisciplinary studies focused on two key dimensions. The former is specialist knowledge regarding threats and the main factors behind them. This comes from vari-

[16]Pure strategies correspond to zero-one logic, and mixed strategies to the probability calculus, sometimes called multi-valued logic.

ous fields of life and academic study. The latter dimension is the quantitative representation of these studies, i.e. the collection of quantitative data in order to utilize the tools of mathematics and statistics for the development of appropriate formal models and algorithms to be applied in security management, in a broad sense. This is then used to draw up strategic procedures, appropriate to various types of threats, to counteract such threats.

The method presented here for security management enables the assessment of threats and making appropriate decisions to counteract such threats.

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