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# RISK ASSESSMENT OF TERRORIST ACTS BASED ON STUDY OF DIVERSITY OF OBJECTIVES

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### *Abstract*

Terrorist acts continue to be a serious problem for Russia, which leads to serious life and material losses, and also has a strong pressure on the government. Types of objectives that are attacked are becoming more and more diverse. Public transport facilities such as railway stations and airports, communication networks, government buildings, public facilities, private businesses, enterprises and many others are at risk of attack. The article examines objective types that terrorists prefer. Objective risk analysis is proposed to use a three-dimensional model that takes into account threat probability, objective vulnerability, and severity of consequences. The article also provides risk calculation and assessment of risk level with a fuzzy synthesis method, as well as two examples of risk assessment that are intended to prove the feasibility of the model. The study used the data from the Global Terrorism Database for six types of objectives that were attacked in the Russian Federation from 1994 to 2017. To analyze the characteristics of a large amount of data, statistical and approximation methods were used, as well as methods of mathematical modeling and risk assessment. The study can help identify potential objectives, assess risk levels and preparation for emergency management. In addition, the paper concludes that in future studies it is necessary to improve assessment method and a classification standard of risk indicators, while optimizing the risk assessment process and paying more attention to the research of specialists in the field of terrorism.



**Keywords:** Terrorism, risk of terrorist acts, risk assessment, model, diversity of objectives.

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## 1. Introduction

Terrorism continues to evolve and expand around the world. As one of the types of technological events, as soon as a terrorist attack occurs, it can lead to serious casualties and material losses, influence on public opinion and put much pressure on the government. Today the types of objectives that are being attacked are becoming more and more diverse. Public transport facilities, such as railway stations and airports, communication networks, government buildings, public facilities, private businesses, enterprises and many others are at risk of terrorism. If we can identify potential objectives that could be attacked by terrorists, assess the level of risk and prepare a management plan in advance, this will be important to crises management.

## 2. Problem Statement

Russian and foreign scientists conduct much research in this area. Wang and Zhuang (2012) studied the types and nature of terrorist attacks that occurred in Russia. Santifort, Sandler, and Patrick (2015) presented points of change in types of attacks and their drivers based on a variety of targets for terrorist attacks. A study by Chatteijee and Abkowitz (2011) provides a methodology to model regional terrorism. Major (2002) first built a quantitative risk model for terrorism based on the game theory. Woo (2002) developed a process to quantify terrorism risk. For the first time, Mohtadi and Murshid (2009) applied a value approach to assess the risk of catastrophic terrorism. Akhmetkhanov, Dubinin, and Kuksova (2018) stated in the paper the process of assessing the risk of terrorist attacks on urban and industrial facilities. Russian scientists Makhutov and Reznikov (2015) studied the methods to assess the risk of terrorist acts at underground stations and technological facilities.

## 3. Research Questions

However, in Russia there are still no studies on the diversity of attacked objectives, and existing risk assessment models refer only to one type of objects and are not universal. Therefore, to solve this problem, this article first examines objective diversity regarding the types of objectives and diversity index. The paper provides the analysis of objective risk through the most common three-dimensional model, which consists of threat possibility (likelihood of attack), objective vulnerability (success of attack), and severity of consequences (damage). Finally, the article calculates the risk and estimates the level of risk with a fuzzy synthesis method, and also provides an example of risk assessment, which is intended to prove the feasibility of using the model.

## 4. Purpose of the Study

The purpose of this paper is to identify the main methods to assess the risks of terrorist acts against potential objectives of various types, which may help to create a risk management plan for the most significant objects in advance and will be important for responding to crises associated with terrorism and managing their consequences.

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## 5. Research Methods

Statistical and approximation methods are widely used to analyze the characteristics of large amounts of data (Ayyub, 2008; Slovic, 2002). The article also uses this approach. The data was taken from Global Terrorism Database. For a simple study, we will divide objective types into six types from 1994 to 2017 in Russia: government, police and army, infrastructure, enterprises, individuals and property, as well as social institutions indicated in Fig. 1. Fig. 1 shows the cumulative number of different attacked objectives since 1994.

## 6. Findings

Since urban areas have widespread infrastructure such as transport, water supply systems, electricity, communications networks, telecommunications, etc., to which terrorists have easy access, the cumulative number of attacks against them has remained relatively stable since 2015. The social infrastructure represented by educational institutions (schools and kindergartens), hospitals and clinics, editorial boards of the media, NGOs and charitable organizations, as well as other socially significant facilities, is particularly vulnerable. The attack on such objects, which affects the normal functioning of the city, can cause widespread public panic. The cumulative number of attacks by businesses and individuals in the past few years is lower than the infrastructure, but still growing. These two types of objectives, to which terrorists have easy access, and whose employees have lower awareness of countering terrorism, have recently become highly favored targets.

**Table 01.** Attack time and percentage for six types of terrorist objectives according to Global Terrorism Database

| **Types of attack** | **Number** | **Percentage** |
|---|---|---|
| Enterprises | 199 | 9,1 |
| Government | 406 | 18,5 |
| Infrastructure | 224 | 10,2 |
| Social infrastructure | 190 | 8,7 |
| Police and army | 816 | 37,2 |
| Individuals and property | 271 | 12,4 |
| **Total** | **2194** | **100,0** |

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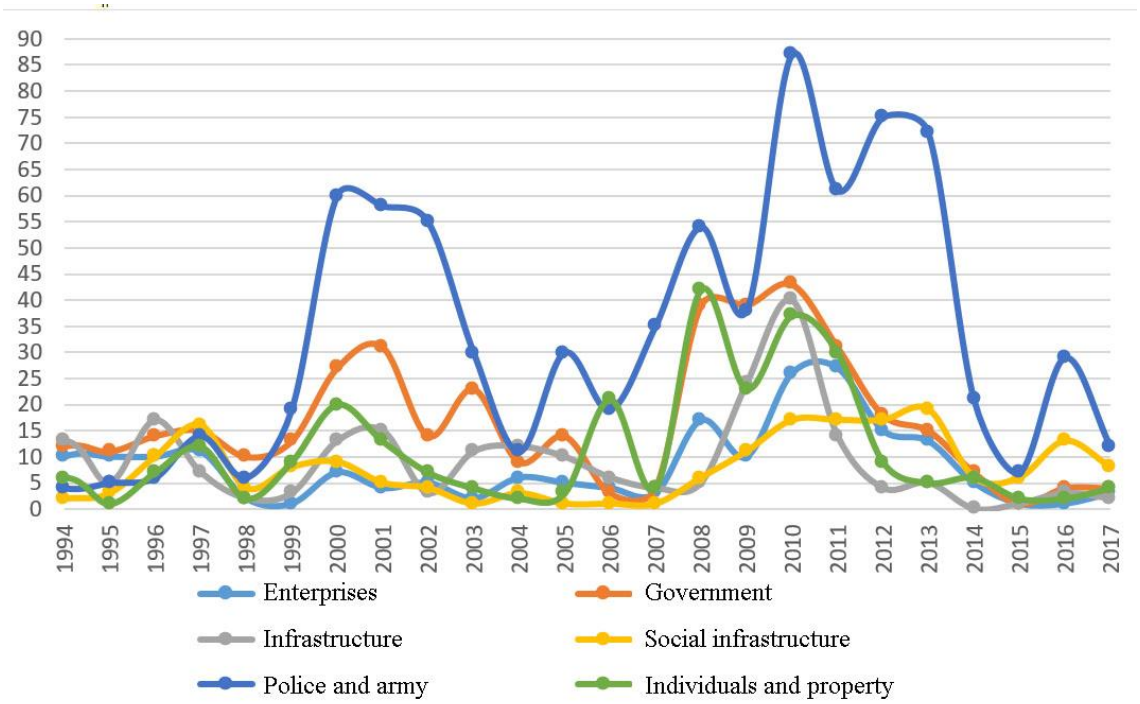


**Figure 01.** Total number of attacks from 1994 to 2017 in Russia according to Global Terrorism Database

In the overwhelming majority, attacks occur precisely at the police stations and the army. Attacks on these objectives put a lot of pressure on the government and reduce public confidence in law and order, because it indicates their vulnerability or "helplessness" to terrorists (Table 01).

In short, social infrastructure, as well as the police and the army are the main objectives for terrorists. As can be seen from Fig. 1, the trend of cumulative growth of numbers for six types of objectives shows similarities. They have a higher level of growth in 1997, 2004, 2015 and 2017. Why these years can be the special points? Table 2 which shows objective types and events over the four years, may provide some answer.

**Table 02.** Analysis of key years

| Year | Objective type | Event of the year |
|---|---|---|
| 1997 | 1) social infrastructure; 2) government; 3) police and army; 4) individuals and property частные. | January 27- presidential and parliamentary elections were held in Chechnya, which were held under the control of illegal armed gangs;<br>September 13-negotiations in Dagomys on the preparation to sign political treaty between Russia and Chechnya. |
| 2004 | 1) infrastructure; 2) police and army; 3) government; 4) enterprises (business). | March 14 - Presidential Election was held;<br>June 21- The Second Chechen War: an armed attack by Chechen and Ingush militants on Ingushetia;<br>August 21-The Second Chechen War: 400 militants attacked Grozny.<br>August 24-a suicide bombing on the board of two passenger planes of domestic flights;<br>September 1-the seizure by terrorists of a school in Beslan. |

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|---|---|---|
| 2015 | 1) police and army; 2) social infrastructure. | July 3 - the adoption of patriotic "stop list" of 12 organizations whose activities are undesirable in Russia;<br>September 30 - permission to use the Armed Forces of the Russian Federation in Syria;<br>October 31 - the collapse of the liner of the Russian airline "Kogalymavia" in Sinai. |
| 2017 | 1) police and army; 2) social infrastructure. | December 6 - statement on the complete release of the Syrian Arab Republic from the militants of the "Islamic State" (reserved in the Russian Federation).<br>December 18 - start of the presidential election campaign. |

**Index of diversity objectives.** In the article we use to calculate the index of diversity as equation (1).

$$\text{Index} = 1 - \sum_{i}^{n} S_i^2$$

$S_i$ is the proportion of total attacks on objective type i when measuring objective diversity; n is the total number of objective types; the measure of diversity varies from 0 to 1, with 0 indicating no diversity and 1 indicating complete diversity. N is the number of targeted attack types. Fig. 2 shows the diversity index and the number of attacks in each year since 1994.

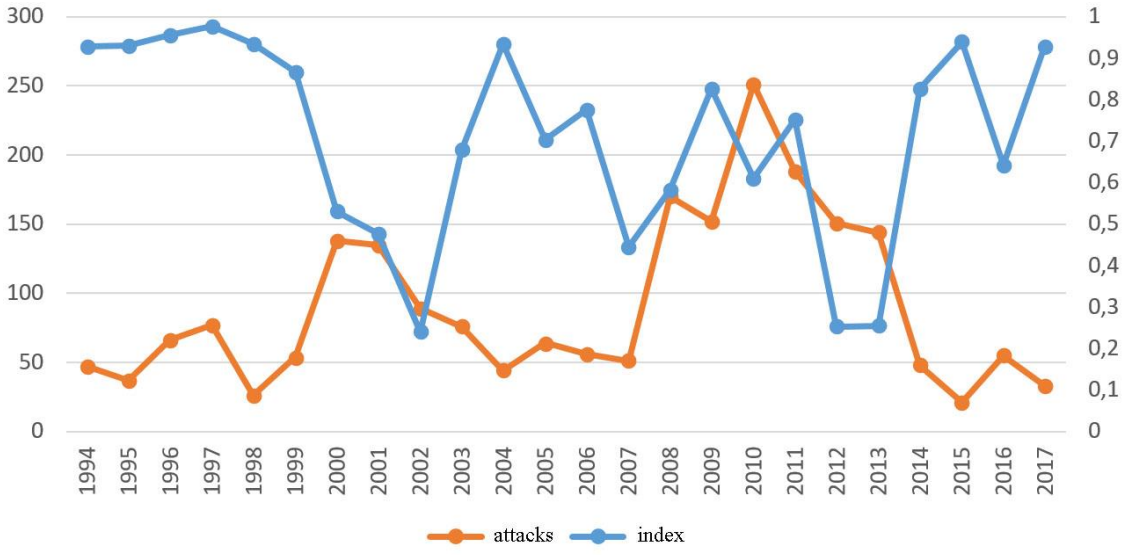


**Figure 02.** Diversity index and number of attacks from 1994 to 2017

Fig. 2 shows the peak points of diversity over 1997, 2005, 2015 and 2017, which have a certain similarity with the situation in Fig. 2. In addition, diversity index has a negative relation with the number of attacks, that is, the diversity index increases, and the number of attacks decreases ($r = -0.528$ with $p < 0.01$). This can be explained by the fact that the more diverse the attacked objectives, the more resources terrorists spend on planning and organizing attacks. However, there are three points, in 2001-2002, 2008 and 2010-2013, which show a positive correlation. This means that the number of attacks of one or several

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types of objectives has increased dramatically. At different periods, terrorists prefer different objectives and, more recently, they may prefer to attack the police and social infrastructure.

**Target risk analysis model and indicators.** When we know the objectives that terrorists prefer, it is necessary to assess the level of risk in advance and take management measures. As already mentioned, different objectives have different appeal to terrorists (Garrick, 2004). If the objective of terrorists is to exert pressure on the government, then the attractiveness of government facilities is higher than the business buildings with high density of personnel. However, if the level of foreign defense or anti-terrorism deterrence measures is high and it is difficult to attack successfully, the government's appeal will decrease (Renfroe & Smith, 2002). Thus, the attractiveness and level of objective defense are important factors that we must take into account, and they will influence the objective risk of attack. Based on the classical risk theory, the article examines objective vulnerability, which is affected by the level of attractiveness and protection, applies a risk analysis of the objective with a three-dimensional model of the terrorist attack, which consists of threat capability, objective vulnerability, and severity of consequences.

**Chance of attack or threat.** The first step in risk management is to assess threat possibility. A terrorist act as a man-made disaster has a very high degree of randomness, and attack probability is difficult to quantify. However, according to objective diversity, terrorists choose objectives consistently and regularly. Thus, we can predict threat possibility for attacks as a historical situation, which consists of two factors: whether the objective or a similar object suffered from a terrorist attack or not, and whether the threat was identified by law enforcement agencies or not.

**Objective vulnerability.** Vulnerability is the ability to resist adverse effects. High vulnerability objectives can be easily attacked (Willis, 2005). In the article, two aspects affect objective vulnerability: internal attractiveness and external protection. The internal attractiveness of the objective is an indicator of positive correlation with vulnerability, determined by the density of personnel and property, political significance and functional significance. External protection, as determined by physical protection and emergency management measures, is a negative correlation factor with objective vulnerability. Increasing the level of protection may to some extent reduce objective vulnerability.

**Severity of consequences.** The severity of the consequences means the potential serious losses and widespread influence caused by a terrorist attack, including direct and indirect damages. Losses of human lives and property, damage or termination of operation are direct consequences. Then indirect effects relate to invisible influences, such as social panic, public opinion and pressure on government. Table 3 shows the classification and threshold values of three above factors.

**Table 03.** Classification and threshold values of three components of risk

| Index | Category | Value | Description |
|---|---|---|---|
| Probability of attack | Certain threat (I) | >76 | Objective or similar object suffered from the terrorist attack and the threat was identified by special services. |
| | Possible (II) | 50-75 | Objective or similar object suffered from the terrorist attack and the threat was not identified by special services. |
| | Potential (III) | 25-49 | The area near the objective suffered from the attack, but not the objective. |

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| | | | |
|---|---|---|---|
| | Minimal (IV) | <25 | Objective and surrounding area were not affected by the attack. |
| Objective vulnerability | Very high (I) | >76 | A nationally significant objective that has a very high appeal to terrorists, and protection measures or level of protection are extremely insufficient. |
| | High (II) | 50-75 | A regionally significant objective, a great attraction for terrorists and protection measures or level of protection are insufficient. |
| | Medium (III) | 25-49 | Regional objective with potential appeal to terrorists and inadequate protection |
| | Maximum (IV) | <25 | Sufficiently low-profile objective, which has a possible attractiveness for terrorists and a sufficient level of protection (adequate) |
| Consequences | Catastrophic (I) | >76 | Most people or assets are destroyed without the possibility of recovery; functioning is completely impossible and cannot be restored in a short time; serious indirect effects. |
| | High (II) | 50-75 | Many people or property are damaged; the operation of part of the object is stopped and can be restored after some time; some degree of indirect effect. |
| | Medium (III) | 25-49 | Some people or property is lost; general operation continues, some functions are temporarily stopped and can be restored after a short period of time; low indirect effects. |
| | Low (IV) | <25 | Almost no loss of people and property; functioning continues. There are no indirect influences. |

**Risk level assessment.** This paper uses a fuzzy decision method to calculate risk level (Cox, 2008). The fuzzy decision making method is currently widely used in risk assessment. Using this method, all risk factors can be considered on the basis of the principle of fuzzy transformation and the principle of maximum degree of belonging for quantifying and solving multiple factors. The model is as follows.

(1) Confirmation of the set of risk factors U = {u1, u2, ..., un} and the set of solutions V = {v1, v2, ..., vn}. U = {threat capability, target vulnerability, severity}, V = {very high, high, medium, low};

(2) Weight calculation of each factor with the method of expert assessments and analytical hierarchical process: W = {$w_1$, $w_2$, ..., $w_n$}, $\sum_{i=n}^{n} w_i = 1$

(3) Construction of the estimated set R. The choice of the coefficient i in the multiplier U and the estimate of the degree of its belonging rij to the element j from the set of solutions V in the form of Table 2. Then we know one-sided estimated matrix R = {$r_{i1}$, $r_{i2}$, ..., $r_{in}$}, then comes the construction of comprehensive assessment matrix R.

Comprehensive assessment matrix $R = \begin{bmatrix} r11 & r12 & r13 & r14 \\ r21 & r22 & r23 & r24 \\ r31 & r23 & r33 & r34 \end{bmatrix}$

(4) Risk assessment with an equation B = W*R, then we know risk matrix RD = {$r_1$, $r_2$, $r_3$, $r_4$} and calculate risk with the formula ScoreR = ($r_1$, $r_2$, $r_3$, $r_4$)*(88.5, 62.5, 37.5, 12.5)-1, and $r_i$ = (i=1,2,3,4) represents the degree of risk distribution of each risk level. The risk level is shown in Table 4.

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**Table 04.** Description of risk levels

| Level | Description |
|---|---|
| Very high I (unacceptable) | Risk level is totally unacceptable and measures should be taken immediately to reduce risk. |
| High II (unsatisfactory) | Risk level is unacceptable and measures should be taken to reduce the risk as soon as possible. |
| Moderate III (controlled) | Risk level is controlled and acceptable in the short term, but measures must be taken to reduce and mitigate risk in long-term plans. |
| Low IV (acceptable) | Risk level is acceptable, and risk reduction and risk reduction measures must be continuously updated and implemented. |

**Practical example**

(1) A business building with 20 floors located in the regional city of an unstable region (for example, Russian republics of the North Caucasus), which accommodates many workers. This objective has never been attacked by terrorists before, and threat attack was not identified by the security services. However, the building has taken some security measures.

(2) A city police station located in an unstable region in which there are several police officers with weapons, experience and skills. A similar objective had previously been attacked by terrorists, so the threat attack was determined.

In the example, the set of factors is U = {probability of attack, objective vulnerability, severity of consequences}, and the set of judgments is V = {very high, high, medium, low}. The results of risk assessment are shown in Table 5.

**Table 05.** Result for examples

| Objective | Weight | Comprehensive assessment matrix | Risk sharing | Risk value |
|---|---|---|---|---|
| Business buildings | {0.1528, 0.1988, 0.6484} | $\begin{bmatrix} 0,1 & 0,55 & 0,3 & 0,05 \\ 0,25 & 0,5 & 0,15 & 0,05 \\ 0,15 & 0,55 & 0,3 & 0 \end{bmatrix}$ | {0.1622, 0.5401, 0.2702, 0.0176} | 58.45 II, III |
| Police station | {0.5341, 0.2390, 0.2269} | $\begin{bmatrix} 0,55 & 0,3 & 0,1 & 0,05 \\ 0,1 & 0,4 & 0,4 & 0,1 \\ 0,05 & 0,35 & 0,6 & 0 \end{bmatrix}$ | {0.3023, 0.3352, 0.2852, 0.0506} | 59.03 II, I |

Based on Table 4, business risk level is II and tends to decrease to III, while risk level for the police station is II, and tends to I. Both of risks belong to the II level, which proves that they are face a high risk of being attacked. At the police station, measures should be taken to reduce the risk and mitigate the threats immediately or as soon as possible, for example, such as strengthening medical monitoring, improving emergency response skills. In relation to business, measures should be taken as soon as possible to reduce the risk, and future plans should consider additional measures, such as strengthening control over access to the building, drawing up action plans and training employees in emergency situations to eliminate a specific threat attack.

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## 7. Conclusion

In this paper, we studied the diversity of objectives for terrorist attacks, which helps to identify the types of objectives that terrorists recently prefer. Then, the analysis of objective risk of a three-dimensional model was presented, taking into account threat probability, vulnerability of objectives and consequences. Finally, risk level was assessed with a fuzzy decision-making method. Two examples of risk analysis of business and police objectives were cited. The study can help identify potential objectives, assess objective risk levels and prepare for emergency management. However, research still has some problems. In future studies, it is necessary to improve the assessment method and classification standard of risk indicators, while optimizing the risk assessment process and paying more attention to the research of specialists in the field of terrorism.

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