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## **THE *MODUS OPERANDI* OF TERRORIST ATTACKS USING IMPROVISED EXPLOSIVE DEVICES IN LANDSIDE ZONES FROM 2001 TO 2018**

### ***Modus operandi* ataków terrorystycznych przy użyciu improvizowanych urządzeń wybuchowych w strefie ogólnodostępnej w latach 2001-2018**

**Abstract:** *The paper concerns the analysis of changes in the modus operandi of terrorist attacks in the landside zones, in order to identify the areas that are most vulnerable to attack using IEDs. Attacks carried out in the passenger terminal and in the car parks were analysed.*

**Keywords:** *aviation terrorism, airport, civil aviation*

**Streszczenie:** *Praca dotyczy analizy zmian modus operandi ataków terrorystycznych w strefie ogólnodostępnej, w celu wskazania obszarów, które są najbardziej narażone na atak przy użyciu IED. Analizie poddane zostały ataki przeprowadzone w terminalu pasażerskim oraz na terenie parkingów.*

**Słowa kluczowe:** *terroryzm lotniczy, port lotniczy, lotnictwo cywilne*

## 1. Introduction

Improvised explosive devices (IED) are one of the key threats to civil air transport [12, 27]. Following the simultaneous attacks of 11 September 2001, recommendations were developed that subsequently provided new elements of security systems and procedures aimed to reduce the risk of in-flight aircraft hijacking and introduction and use of IEDs on board aircraft [18]. It is also pointed out that there is a constant need to strengthen security controls [16, s. 1148], e.g. due to the ever present and new (e.g. due to the use of modern components) threats of IEDs placed in checked baggage [22, p. 173]. However, these measures protect primarily aircraft with the crew and the passengers on board. On the other hand, the March 2016 suicide terrorist attack at the Brussels Airport, which serves as a good example due to the number of victims and the media coverage, points to the need for increased security even before the security checkpoint [3, p. 17], particularly as civil aviation continues to be an attractive target for terrorist attacks.

What should also be pointed out at the outset is that the author emphasizes the essence of the distinction between a terrorist attack and a terrorist plot. A terrorist plot is a planned operation that consists of six elements: intent; identification and selection of the target (object); development of an action plan; preparation of the attack; execution of the attack; and exploitation of the benefits gained from the attack – execution of the attack constitutes the most destructive stage of a plot [26, p. 96].

The holistic aspect of civil aviation security consists of three pillars: aircraft security; airport security; and air traffic security [6, p. 1]. Nevertheless, the main object of security in civil aviation is the aircraft with the crew and the passengers on board [24, p. 120-121], while the elements most vulnerable to terrorist attacks are the aircraft and the airport [15, p. 21]. In terms of airport security, these objects are undoubtedly classified as elements of critical infrastructure [7, p. 4; 10; 29, p. 7]. However, from a practical point of view, their strategic elements are located in a restricted zone that is very well protected [23, p. 243]. In contrast, the zone that is most vulnerable to an attack, which also contains large concentrations of people, cannot be fully protected due to organizational problems. The above conclusions clearly indicate significant systemic gaps, where the biggest challenge is to strengthen the anti-terrorist protection of the airport, with a special focus on the landside zone as a soft target [4, p. 7].

## 2. Materials and Methods

The subject of this article is an analysis of terrorist attacks perpetrated using IEDs between 2001 and 2018 in the landside zones of airports. The aim of the article is to indicate the changes that take place in the *modus operandi* of the perpetrators of terrorist attacks and to characterize the methods of attack using IEDs. In addition, the study presented herein was carried out from the standpoint of the system for protecting civil aviation against acts

of unlawful interference. According to the author, this research approach enables three important issues:

- determination with greater effectiveness of the risk of a terrorist attack using a specific attack method;
- identification of the most vulnerable infrastructure elements; and
- improvement of systems for safeguarding civil aviation against acts of unlawful interference.

The research problem discussed in this paper takes the form of the following question: What were the trends in the methods of terrorist attacks against targets located in landside zones of airports between 2001 and 2018? It is helpful to formulate a specific question: Which elements of the infrastructure of landside zones are the most common sites/targets of attacks using IEDs? Two research hypotheses were also constructed:

H1: Aviation terrorism using IEDs is characterized by an increasing level of brutalization of the attacks, which is reflected in an increase in the number of victims of the attacks and an increasingly frequent suicide attacks.

H2: In the case of an attack with an IED in an airport landside zone, the most common place of the attack is the area between the entrance to the terminal and the check-in area, which may be due to the ease of carrying out the attack and the attractiveness of the target.

The material for the research was obtained by conducting a library search and a search of Internet sources in order to make a complete list of terrorist attacks on elements of civil aviation infrastructure in the years 2001-2018 around the world, which included acquiring information on the description of individual attacks, in order to precisely identify the places, the targets, the tools, and the methods of the attacks. The preliminary data analysis process comprised five steps. The first stage of the preliminary analysis focused on listing terrorist attacks using IEDs against civil aviation. According to the GTD, there were 118 terrorist incidents targeting aviation between 2001 and 2018, where the tool of the attack was various types of explosives [8]. The second stage of the preliminary analysis of the quality of the research material involved verification of three key determinants: whether it was definitely a terrorist attack; whether it was definitely an attack on civil aviation; and whether the instrument of the attack was definitely an IED. In the case of the third determinant, it was verified whether the attack tool was an IED, which consists of a triggering device, a fuse, a power source, a detonator, and an explosive, which are most often connected with cables [11, p. 59]; some sources specify slightly different basic elements of an IED, namely a switch, a power source, a fuse, an explosive, and a container [28]. In the fourth stage of the preliminary analysis of the research material, attacks on elements of civil aviation infrastructure outside airports (except aircraft) were eliminated, which is justified by the adopted research perspective from the point of view of the civil aviation security system. Finally, a preliminary analysis aimed to precisely select terrorist attacks using IEDs on elements of civil aviation infrastructure in the years 2001-2018 from the perspective of the system of protection of civil aviation against an act of unlawful interference yielded 73 attacks. Of the 73 attacks identified, 39 occurred in a landside zone and these ultimately formed the research material for this paper.

According to Regulation (EC) no. 300/2008 of the European Parliament and of the Council on common rules in the field of civil aviation security, a landside zone means those parts of an airport, adjacent terrain, and buildings, or portions thereof that are not the airside of an airport (L 97/72, Article 3). In order to standardize the analysis process while keeping the parameters of the attack locations as accurate as possible, 10 locations in landside zones that became the site of terrorist attacks using IEDs in the years 2001-2018 were listed: the terminal (the space between the entrance to the airport building and the check-in desk); the landside zone in front of the terminal (only areas with sidewalks and pedestrian traffic); the entrance to the terminal; the check-in area; the arrivals hall; the parking lot; the entrance to the parking lot; buildings of third-party companies in front of the airport; airport offices to which passengers have no access; and other. It is also important to point out that, from the point of view of this analysis, the author considers a terrorist attack using an IED to be successful if an explosion occurs, regardless of its consequences and the number of casualties.

### 3. Results

Between 2001 and 2018, 53% of attacks using IEDs on civil aviation targets were conducted in the landside zone, of which 59% are considered successful attacks. The frequency of attacks between 2001 and 2018 in the landside zone is in line with the general trend in the frequency of attacks on civil aviation targets. The largest numbers of attacks in the landside zone were recorded in 2001 and 2014.

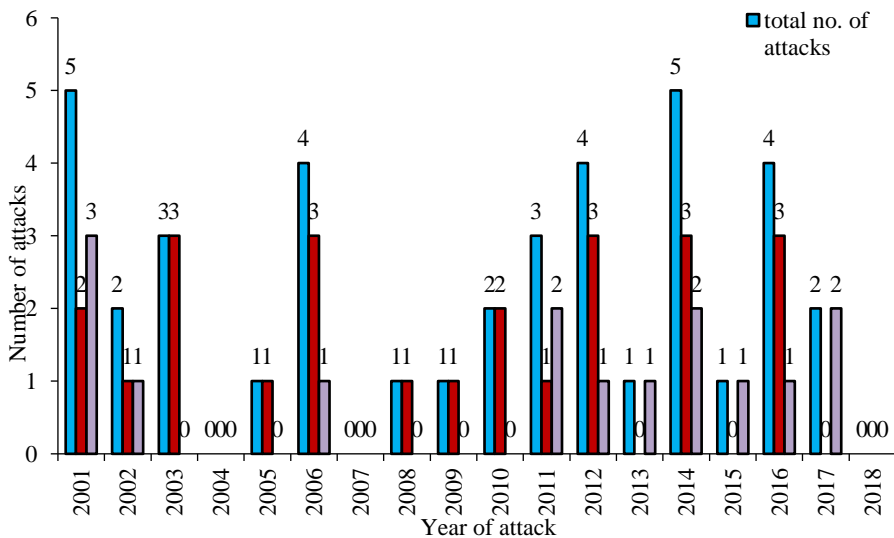
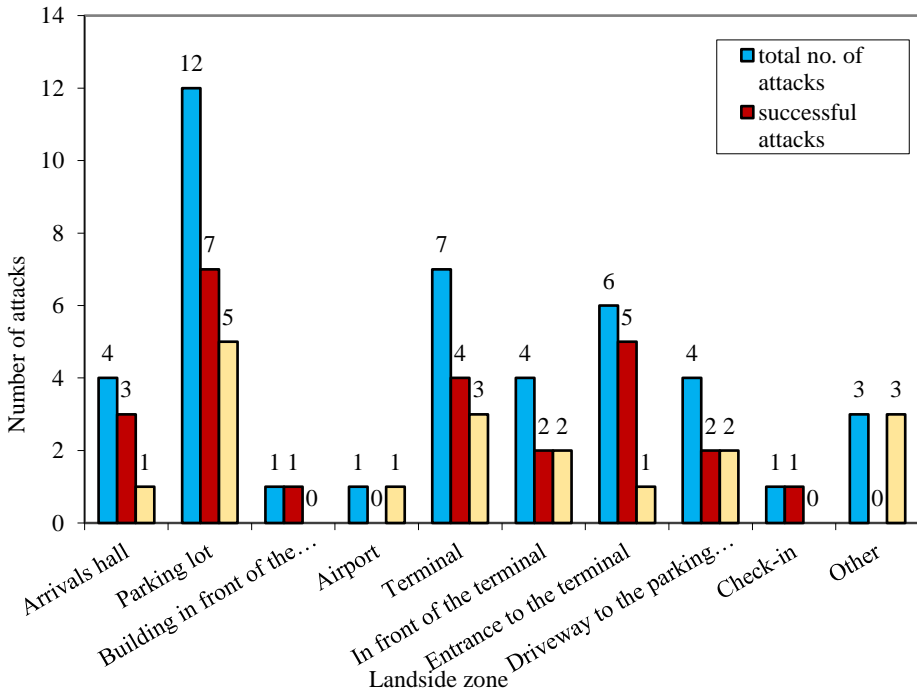


Fig. 1. The number of terrorist attacks using IEDs in the landside zone in the period of 2001-2018

Figure 1 shows a division into two periods that were characterized by a different scale of attacks. Between 2001 and 2009, 17 attacks (44% of all attacks using IEDs on civil aviation targets) were reported in the landside area, including 12 successful attacks (31% of all attacks using IEDs on civil aviation targets) and 5 failed attacks (13% of all attacks using IEDs on civil aviation targets). In the second period, between 2010 and 2018, there were 22 attacks (56% of all attacks using IEDs on civil aviation targets), including 12 successful attacks (31% of all attacks using IEDs on civil aviation targets) and 10 failed attacks (26% of all attacks using IEDs on civil aviation targets). The frequency of attacks between 2001 and 2018 in the landside zone is in line with the general trend in the frequency of attacks on civil aviation targets. The largest numbers of attacks in the landside zone were recorded in 2001 and 2014.



**Fig. 2.** The location of terrorist attack sites using IEDs in the landside zones of airports from 2001 to 2018

Figure 2 with individual targets of attacks includes a total of 43 locations because some attacks were carried out in more than one location. For the purpose of this paper, a terminal means the interior of a building in the landside zone of an airport intended for handling of passengers (excluding check-in) and additional services (catering, shopping arcades, post offices, car rental companies, etc.). The terminal was the attack location for 16% of all attacks in the landside zone, with 57% of attempts in the terminal considered a successful attack. The landside zone in front of a terminal is defined as the space between the parking

lot and the entrance of the terminal. There were 4 attacks in this zone (9% of all attacks in the landside zone), including 2 successful attacks and 2 failed ones. The entrance of the terminal became the attack location for 14% of attacks; 83% of all attacks near the terminal entrance are considered successful. So far there has been one case of a successful attack near a check-in point, which occurred on 22 March 2016 in Belgium (Zaventem). There were four attacks in the arrivals hall (9% of all attacks in the landside zone): three successful and one unsuccessful.

In the landside zone, the largest number of attacks occurred in the parking lots, with 12 attacks, which represents 28% of all attacks in the landside zone; 58% of all attacks are considered to be successful. In the case of the parking lot, the area in front of the terminal, and the entrance to the terminal, there is also a separate method of attack, which is the use of a vehicle - planting an IED and a suicide attack using a vehicle, usually a car. The method of a bomb attack using IEDs, referred to as Vehicle-Borne Improvised Explosive Device (VBIED), has been attracting more and more attention from experts for several years [17, p. 192]. This method includes both leaving an IED in a vehicle near the target of the attack and a suicide attack using a VBIED [9]. Three basic methods of using VBIEDs are identified: as hiding places for portable bombs - in this case the possibilities are classical planting of IEDs and suicide attacks, as exemplified by the 2012 attack in the Burgas airport's parking lot by a Hezbollah suicide bomber; as static booby-trap bombs left in the parking lot and detonated remotely; and as mobile bombs guided by suicide bombers, which can move at high speed, ramming into obstacles and slamming into a selected target [2, p. 28].

Attacks at the entrance to a parking lot account for 9% of the total number of attacks in the landside zone, a half of which are considered successful. Between 2001 and 2018, there was one attack on a building in front of an airport (23 November 2002, South Africa), which represents 2% of all attacks in the landside zone. The "other" category contains 3 failed attacks carried out in a landside zone that cannot be accurately classified due to limited sources of knowledge. Of the 39 attacks, 8 types of attacks using IEDs were distinguished: (1) IED as the only tool of attack; (2) More than one IED used in the attack; (3) A single suicide attack using an IED; (4) A suicide attack using an IED carried out by more than one suicide bomber; (5) A suicide attack carried out by more than one attacker using an IED and another attack tool; (6) An IED left in a vehicle; (7) A suicide attack using a VBIED; and (8) More than one suicide attack using a VBIED.

## **4. Attacks with IEDs and without a vehicle**

In 72% of the cases, VBIEDs were not the tool used in the attacks. The effectiveness of an attack using an IED without the use of a vehicle is 61%. In the case of 61% of attack attempts without a means of transport, the method of attack was a single IED; the effectiveness of this method is 71%. The second most common method of attack is a suicide attack using IEDs, with 5 attacks recorded (17%), the effectiveness of which is 60%. An

attack with more than one IED was the third most common method of an attack without a vehicle and occurred three times with the success rate of 66%. Suicide attacks account for 29% of all attacks in this category, of which 75% are considered successful. The most common method of a suicide attack was a single attack using an IED (5 attacks), followed by an attack by more suicide attackers using an IED and another attack tool (two attacks), and attack by more than one suicide attacker using an IED (one attack) - both methods of attack were 100% successful.

As for the frequency of use of different methods of attack without the use of a means of transport, the most frequent was planting of IEDs (17 times), with the largest number of attacks in 2001 (4 attacks) and especially in 2012-2017 (7 attacks). The second most common method, i.e. a single suicide attack, occurred in 2003, 3 times in 2011, and once in 2012. A suicide attack carried out by more than one terrorist using more than one attack tool was reported in 2014 and 2016. In contrast, the only attack with an IED used by more than one attacker took place in 2016. The last type of attack, with more than one IED used for the same attack target, occurred in 2001, 2015, and 2017.

The final factor is related to fatality rates. In attacks involving planting of IEDs, two persons were killed, 14 were wounded, and also one terrorist was killed. The fatality rate for this method is 0.12 victims per attack. When more than one IED was planted for the same attack target, no persons were killed and 3 people were wounded. In the case of a single suicide attack, 68 persons were killed, 326 persons were wounded, and 5 terrorists were killed. In this case, the fatality rate per attack is 13.6 persons killed, 65.2 wounded persons, and 1 dead terrorist. In the only suicide attack carried out by more than one terrorist, where the only tool of attack was an IED, 16 people were killed, 135 were wounded, and two terrorists were killed. In two attacks carried out by more than one terrorist using an IED and another attack tool, 73 people were killed, 257 were wounded, and 13 terrorists were killed. In this case, the fatality rate is 36.5 persons killed, 128.5 persons wounded, and 6.5 dead terrorist per attack.

## **5. Terrorist attacks using VBIEDs in landside zones in the years 2001-2018**

Between 2001 and 2018, eleven attempted terrorist attacks with IEDs on civil aviation targets in landside zones of airports involved direct use of vehicles (VBIED), with ten cases involving a car and one case in 2012 in Colombia where a bicycle was used in the attack. A distinction is made between planting an IED in a vehicle, a suicide attack, and more than one suicide attack. In total, attacks using a vehicle account for 15% of the total number of terrorist attacks using IEDs on civil aviation targets between 2001 and 2018 and for 28% of attacks in the landside zone. 54% of attacks using VBIEDs involved leaving an IED in a vehicle, of which 66% attacks using this method are considered successful. A single suicide attack using a VBIED accounts for 36% of all attacks, of which 50% are considered

successful. There was also one suicide attack with more vehicles and suicide terrorists - there were 9% of attacks in this category and the success rate was 100%. Attacks according to the most common method in this category (IEDs left in vehicles) took place in 2003, twice in 2006, and once in 2010, 2012, and 2014. A single suicide attack using a VBIED was reported in 2009, 2010, 2014, and 2016. More than one suicide attack using a VBIED in a single plot took place in 2006. Due to such a small number of attempts, 3 periods of increased frequency of attacks can be identified, namely 2006 (3 attempts), 2009-2010 (3 attempts), and 2014-2016 (3 attempts).

**Table 1**

**Distribution of attacks with fatalities during terrorist attacks using IEDs on civil aviation targets in the years 2001 to 2018**

Year of attack	Total number of attacks	Number of successful attacks	Number of successful attacks with killed/wounded persons	Number of persons killed and wounded
2001	5	3	1	0/3
2002	2	1	0	0
2003	3	3	2	25/150
2004	0	0	0	0
2005	1	1	1	1/12
2006	4	3	3	17/14
2007	0	0	0	0
2008	1	1	1	0/1
2009	1	1	1	7/14
2010	2	2	1	4/3
2011	3	1	1	37/168
2012	4	3	1	7/8
2013	1	0	0	0
2014	5	3	2	28/23
2015	1	0	0	0
2016	4	3	2	61/370
2017	2	0	0	0
2018	0	0	0	0
<b>TOTAL</b>	<b>39</b>	<b>24</b>	<b>16</b>	<b>187/766</b>

When the number of dead persons and injuries is analyzed, attacks involving leaving an IED in a vehicle resulted in 3 deaths and 14 injuries. In this case, the fatality rate is 0.5 persons killed and 2.3 wounded persons. In suicide attacks using VBIEDs, 11 people were killed, 17 were wounded, and 3 terrorists were also killed. In this case, the fatality rate is 2.75 persons killed, 4.25 persons wounded, and 0.75 terrorists killed - because two attacks were stopped by agencies, while one attack involved two suicide terrorists, but in one car. In the only terrorist attack that involved more than one suicide attack using a VBIED, 14 people and two terrorists were killed. In general, suicide attacks using VBIEDs have



a fatality rate of 5 persons killed, 3.4 persons wounded, and 1.4 terrorists killed. Between 2001 and 2018, 187 people were killed and 766 were wounded in terrorist attacks using IEDs in the landside zones of airports. The most violent period in terms of the number of victims was between 2009 and 2012, with at least one attack with a person killed recorded each year. On the other hand, the most brutal attack took place in 2016, when 61 people were killed and 370 wounded; two of the three bombers were also killed in the attack.

## **6. Discussion**

In the case of terrorist attacks using IEDs in landside zones of airports, two time periods are noticeable, which are characterized by different frequency of attacks, number of victims, and popularity of the attack methods used. In the first period, i.e. between 2001 and 2009, 17 attacks took place, with 12 (71%) of them successful and 50 people killed. In the second period, i.e. between 2010 and 2018, 22 attacks took place, with 12 (55%) of them successful and 137 people killed. Although the effectiveness of the attacks in the second period was 15% lower, the number of victims was more than twice as high as in the first period. The increase in the fatality rate despite the lower effectiveness of the attacks is justified by the higher frequency of suicide attacks, which indicates an increase in the brutality of the attacks. Thus, the trends that characterize terrorist attacks using IEDs in landside zones fit the concept of four waves of jihad [20, p. 72]; moreover, the second period has the characteristics of postmodern terrorism, as defined by Laqueur [14, p. 27; 5, p. 50]. Another negative trend is an increase in the frequency of attacks in landside zones from 44% in the first period to 56% in the second period.

The most common method of attack was leaving a single IED and the second most common method was a single suicide attack and leaving an IED in a vehicle. In the case of the most common method of attack, the fatality rate is low and equal to 0.12 people killed per attack. In this respect, the second most common method, i.e. a suicide attack without a means of transport, with the fatality rate of 13.6, is far more dangerous; also, the fatality rate of a single suicide attack using a VBIED is much higher and equal to 2.75. It is significant that the second and third most common method of attack was more likely to be used in the second time period. As for the most frequent place of attack, the parking lot was indicated, followed by the terminal in the second place and the entrance to the terminal in the third place. In the context of the greatest popularity of parking lots, it is important to point out that the use of VBIEDs only became more popular in the second time period; the disparity in the fatality rate is also clear, where in the case of planting an IED in a car it is 0.5, while in the case of a suicide attack (single and simultaneous) the fatality rate is 5 victims per attack.

It is worthwhile to present a polemic on the consideration of the state of affairs discussed above. Based only on a superficial and intuitive analysis of the landside zone, the check-in area can be considered as the most attractive target due to the large number of passengers and the fact that they are not moving while waiting in line. However, it is the parking lot and the area between the entrance of the terminal and the check-in point, as well as the terminal

entrance itself, that are by far the most common locations of terrorist attacks. Why? One can start with a statement that is outside the scope of this paper, namely that the airside zone of an airport is not an attractive target for an attack, because in order to bring an IED into the airside area, one has to cross the security check zone, which is the boundary between the landside zone and the airside area, which actually means that one has to take exactly the same route as that is required to bring an IED aboard an aircraft, which is by far a more attractive target for an attack - if the terrorist is able to navigate this route, it is logical that it is better to use an IED aboard an aircraft. It can also be argued that it will not matter to most of the public whether an attack took place in an airside zone or a landside zone, as most people will understand it as an attack on the airport - in which case an attempted attack in an airside zone is ineffective given the high level of difficulty and low attractiveness. It could be argued that the security check area could be a backup target for an attack if an attempt to bring an IED aboard an aircraft proved impossible. However, it may be pointed out that in the case of an attempt to bring an IED on board an aircraft, due to the technology used in security systems, terrorists would have to carry the IED in several parts in order to deceive the security staff, which limits the possibility of exploding the IED if a terrorist is uncovered during a security check [25, p. 200-211]. Thus, there is only a potential risk of a premeditated detonation of an IED at a security checkpoint; the situation is similar at a check-in point. The security check area and the check-in point seem attractive, but the low number of attacks in those locations may be due to the stress level of the terrorist who, when wanting to carry out an attack inside an airport building, due to the high stress level and the fear of being uncovered, prefers to carry out the attack as soon as possible, i.e. near the entrance of the building. In addition, if an IED is left behind, it is much easier to plant an unnoticed charge, such as left-over luggage or trash, in a less used part of the airport or near a doorway where moving people will not pay attention to the item that is left behind. The same argument can also explain the attacks conducted in the parking lot. Leaving an IED in a parking lot in a bag, by a trash bin, or as a VBIED, is relatively easy and gives the terrorist more comfort due to his level of security and less chance of being detected and captured. In the case of suicide attacks using a VBIED, it is also an easier method of attack because the terrorist has the added effect of surprise. The fact that attacks are carried out in parking lots can be a consequence of improvements to security systems and an attempt to push terrorist threats as far away from the aircraft as possible, and thus outside the airport, as well as a result of an assessment of the attractiveness of particular targets from the terrorists' point of view. There are two arguments in favor of this concept. First, given the same explosive, a small bomb detonated in a terminal will cause more damage and may be more lethal than a larger bomb detonated in the open space of a parking lot or in a car [21, p. 6]; additionally in the case of a terminal there are issues of increased pressure during an explosion and the structural elements of the airport that can increase the effect. However, on the other hand, it is hard to imagine that terrorists would use the same IEDs in the case of an attack carried out by a person in a building and with a VBIED - the amount of the explosive material in the case of planting an IED in a vehicle and at/under a vehicle will also be different. In the case of an IED on a person, charges weighing between 4 and 15 kg are most commonly used, but they are relatively easy to spot by bystanders and the bomber is

not very mobile; it is also reported that such charges, despite their effectiveness in hitting targets indoors, are unable to threaten the structure of buildings [13, p. 53]. The second argument, on the other hand, relates to the currently dominant trends, with postmodern terrorism at the forefront, which is motivated by religious ideology and in which terrorists are focused on causing as much destruction and on killing as many people as possible, thus going beyond Rapoport's concept of four waves of terrorism [19]. Therefore, the landside zone of an airport terminal is a very attractive target. So why were more attacks carried out in the parking lot than inside the terminal? In this case, it may be crucial to focus solely on suicide attacks.

Between 2001 and 2018, there were 12 reported suicide attacks carried out in the landside zones of airports. This includes 7 attacks using IEDs worn by a person and 5 suicide attacks using VBIEDs. In the first period, i.e. in 2001-2009, there was one single suicide attack without a vehicle and two attacks using VBIEDs (including one attack carried out by more than one suicide terrorist). This shows that only 25% of the suicide attacks occurred in the first period. In contrast, 75% of the suicide attacks occurred between 2010 and 2018. The largest number of suicide attacks (3) occurred in 2011. Suicide attacks by more than one terrorist were reported in 2014 and 2016. This indicates a clear increase in the brutality of the attack methods over time. In the case of attacks using VBIEDs, there was also a slight increase in the number of suicide attacks: they accounted for 40% of all attacks in the first period and 50% in the second period.

## **7. Conclusions**

Between 2001 and 2018, two periods of terrorist attacks using IEDs in landside zones of airports can be distinguished, which are characterized by different trends in the methods used and the fatality rates. The first period, from 2001 to 2009, was dominated by attacks involving planting of single IEDs and a low fatality rate, while the second period, from 2010 to 2018, saw an increase in the level of brutality of the attacks, due to more frequent recourse to suicide attacks. Thus, this confirms the first research hypothesis. In addition, the second period also saw an increase in the popularity of using VBIEDs for attacks, including suicide attacks. However, the second hypothesis was falsified, as the most popular location of attacks turned out to be the parking lot, followed by the area between the terminal entrance and the check-in area, and the terminal entrance. The author pointed out that the check-in area may not be an attractive target in practice due to the need for the terrorist to cover a greater distance to plant an IED (which would also be more difficult in the case of a large number of passengers waiting in line) or to carry out a suicide attack - in which case the difficulty of carrying out the attack outweighs the potential attractiveness of the target. On the other hand, an interesting trend is that terrorists are choosing parking lots as the place/target for their attacks. This may be due to the greater ease of carrying out such an attack, which increases the attractiveness of the target for terrorists. It is also significant that in the case of VBIEDs, the frequency of suicide attacks is greater.

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