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Article

Protecting public spaces and public events against vehicle-borne attacks – the importance of VSB and HVM systems in the context of recommendations for Poland

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Abstract

The aim of the article is to discuss HVM (hostile vehicle mitigation) systems and VSB (vehicle security barriers) as a means of protecting public spaces and public events against the deliberate use of a vehicle as a weapon. The conceptual framework relating to HVM systems and VSBs was organised, and current research standards concerning security devices were presented. The nature of this type of threats and the vulnerability of public spaces to them were discussed, followed by a presentation on the importance of risk analysis, the assessment of access-routes, current testing standards and the practical interpretation of crash-test results. The most common errors made during the design, installation and operation of safety systems were highlighted. A separate section was devoted to a model for designing HVM systems based on threat-scenario analysis, buffer zones, layered protection and organisational responsibility. The article highlights the need to increase awareness of the issue in question in the Polish context and sets out directions for the systemic development of protective measures for public spaces and public events.

Keywords

public event, mass event, protection of public spaces, vehicle-as-a-weapon attack, HVM system, VSB, DoS SD-STD-02.01, ASTM F2656/F2656M, PAS 68, IWA 14-1, ISO 22343.

Introduction

Protecting public spaces from vehicle-borne attacks is an important public safety issue. This is not limited to terrorist acts, but encompasses a broader category of incidents in which a vehicle is deliberately used as a tool to target people in these spaces. The mechanism of the risk itself is of decisive importance: the violent intrusion of a vehicle into a pedestrian zone, utilising its mass and kinetic energy as the primary means of causing harm.

Research in this field is fragmented and interdisciplinary in nature[1]. It includes:

1) studies on vehicle-ramming attacks, in which a vehicle is treated as an easily accessible tool for attacking so-called 'soft targets' and crowded places;
2) institutional documents concerning the protection of public spaces, places of assembly and mass events, including guidelines relating to the planning of safety zones, the separation of vehicular and pedestrian traffic, and the use of HVM (hostile vehicle mitigation) systems;
3) technical norms and standards specifying the methods for testing and classifying barriers designed to protect against vehicle impact, in particular standards relating to VSBs (vehicle security barriers)[2].

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[1] Cf. C.R. Ludbey et al., *Classifying vehicle-as-a-weapon attacks: an inductive taxonomy and design implications*, "Crime Science" 2026, vol. 15, art. 2. https://doi.org/10.1186/s40163-025-00265-7; V. Miller, K.J. Hayward, *'I Did My Bit': Terrorism, Tarde and the Vehicle Ramming Attack as an Imitative Event*, "The British Journal of Criminology" 2019, vol. 59, no. 1, pp. 1–23. https://doi.org/10.1093/bjc/azy017; J.P. Phillips, J.S. Young, W.J. Brady, *Preparation and response to a targeted automobile ramming mass casualty (TARMAC) attack: An analysis of the 2017 Charlottesville, Virginia TARMAC attack*, "American Journal of Disaster Medicine" 2019, vol. 14, no. 3, pp. 219–223. https://doi.org/10.5055/ajdm.2019.0333; P. Hess, S. Mandhan, B. Ganor, *Ramming attacks, pedestrians, and the securitization of streets and urban public space: a case study of New York City*, "Urban Design International" 2022, vol. 28, no. 1, pp. 1–14; A.M. Tsur et al., *Patterns in vehicle-ramming attacks*, "Israel Medical Association Journal" 2022, vol. 24, no. 9, pp. 586–591; M. Cichomski, *How can local governments protect public spaces from vehicle attacks?*, "Terrorism – Studies, Analyses, Prevention" 2025, no. 8, pp. 487–516. https://doi.org/10.4467/27204383TER.25.062.23049; J. Jaźwiński, *Anti-terrorist protection of public facilities and critical infrastructure against attacks with motor vehicles*, "Terrorism – Studies, Analyses, Prevention" 2023, no. 3, pp. 361–409. https://doi.org/10.4467/27204383TER.23.011.17451.

[2] *Public Realm Design Guide for Hostile Vehicle Mitigation*, National Protective Security Authority, https://www.npsa.gov.uk/specialised-guidance/hostile-vehicle-mitigation-hvm/

In the Polish context, this issue remains insufficiently recognised, both at the organisational and project levels. Despite the fact that there have been no terrorist attacks involving vehicles on Polish territory, this threat should not be downplayed, particularly with regard to mass gatherings and other events held in open spaces.

The aim of this article is to discuss HVM systems and VSBs as a means of protecting public spaces and public events against vehicle-borne attacks. The article clarifies the basic concepts relating to protection against such attacks, presents current research standards for security devices, and highlights the most common errors made during the design, installation and operation of HVM systems. The research problem comes down to the question of what conditions must be met for the protection of public spaces and public events against vehicle intrusion to be effective and practical, rather than superficial.

The article poses three research questions: what is the significance of current research standards and the correct interpretation of crash test results for the selection of VSBs? What errors most commonly reduce the effectiveness of HVM system? What elements should an HVM system design model for public spaces and public events include?

This article is both analytical and practical in nature. The author employed methods such as: analysis of the relevant literature, legal acts, standards and standardisation documents relating to VSBs, as well as institutional and expert materials from various national and international bodies, including the European Commission, the JRC, the NPSA, CISA, French, Belgian and German materials, as well as an analysis of empirical data comprising observations from the author's professional practice, examples of implementations and cases of security measures being applied in public spaces.

public-realm-design-guide-hostile-vehicle-mitigation-0 [accessed: 12 IV 2026]; *Vehicle Ramming Action Guide*, Cybersecurity and Infrastructure Security Agency, https://www.cisa.gov/resources-tools/resources/vehicle-ramming-action-guide [accessed: 20 VI 2026]; *Hostile Vehicle Guidelines for Crowded Places*, https://www.nationalsecurity.gov.au/crowded-places-subsite/Files/hostile-vehicle-guidelines-crowded-places.pdf [accessed: 20 VI 2026]; ISO 22343-1:2023 Security and resilience – Vehicle security barriers – Part 1: Performance requirement, vehicle impact test method and performance rating, https://www.iso.org/standard/50080.html [accessed: 20 VI 2026]; ASTM F2656/F2656M-20 Standard Test Method for Crash Testing of Vehicle Security Barriers, https://www.astm.org/f2656_f2656m-20.html [accessed: 20 VI 2026].

Conceptual framework

One of the fundamental problems in the Polish debate on protecting public spaces against vehicle-borne attacks is the lack of consistency in terminology. Colloquial terms, industry-specific simplifications and direct translations are all in use, yet none of them accurately convey either the technical or organisational significance of the various solutions. The lack of conceptual precision leads to design errors, misjudgements regarding the effectiveness of devices, and confusion between security measures and traffic or public order elements. For this reason, standardising the terminology is a prerequisite for further discussion.

The key concept used in this article is HVM. It refers to a system designed to protect against the deliberate use of a vehicle as a weapon. It encompasses all measures designed to limit the possibility of a vehicle intruding into a protected area or to minimise the consequences of such an intrusion. The scope of HVM therefore includes not only infrastructural measures but also organisational, procedural, urban planning and operational solutions[3].

The second concept is the VSB, which denotes specific devices designed to stop, intercept or restrict the movement of a vehicle in a specific threat scenario and tested for this purpose. This category includes both permanent and temporary solutions, as well as mobile ones, provided that their protective function has been confirmed in appropriate crash tests. The appearance of the device, its weight or the manufacturer's marketing claims are not sufficient in themselves for it to be recognised as a VSB in a technical sense[4].

It is acceptable to use the term 'anti-terrorism barriers' as a descriptive label, provided it refers to VSBs used as part of the HVM system. This term may be useful in public or organisational communications, but it does not replace the correct technical classification. In expert discourse, priority should be given to precise terms that allow a distinction to be made between a security system and its constituent parts, as well as between tested devices and solutions with only an apparent security function.

The term 'protective barriers' should be avoided as the primary term in the field of protection against vehicle-borne attacks. It is too broad, vague and, in practice, leads to the erroneous equating of VSBs with road

[3] See: J. Jaźwiński, *Anti-terrorist protection of public facilities…*, pp. 361–407.

[4] Ibid., pp. 362–364.

safety features, traffic calming measures or random street furniture. It may suggest equivalence between solutions which, from a safety perspective, have entirely different technical and operational statuses.

The article therefore adopts the following distinction: HVM refers to a system designed to prevent the deliberate use of a vehicle as a weapon, whilst VSB refers to the physical devices that form part of this system, provided their effectiveness has been confirmed by tests specific to this type of threat.

The nature of the threat and the vulnerability of public spaces

A vehicle-borne attack is one of those threats whose effectiveness stems from a combination of three factors: simplicity of execution, widespread availability of the means, and the ability to affect – with the direction and timing of the attack chosen appropriately – a large number of people in a short time. The perpetrator does not need to have advanced technical resources or complex logistics at their disposal. For this reason, this threat is of particular significance in the context of securing public events and all areas with high concentrations of pedestrian traffic.

This type of attack involves using a vehicle as a carrier of kinetic energy, directed directly against people in a public space. This means that the primary mechanism of harm is not the vehicle itself, understood as a means of transport, but its mass, speed and ability to intrude into an area where it should not be. From a public safety perspective, this has serious implications: the threat assessment cannot focus solely on the perpetrator's intent, but must also take into account the conditions that enable the attack to be carried out.

Events held in open spaces are most vulnerable to this type of attack, particularly those of a temporary, seasonal or occasional nature, e.g. fairs, festivals, cultural or religious events that require roads to be closed. Their vulnerability stems from their accessibility by public transport, high crowd density, limited ability to fully control all access routes, and the frequent absence of permanent security measures[5].

From the perspective of a potential perpetrator, targets of this kind are also attractive because of the psychological and media impact they have.

[5] See: M. Cichomski, *How can local governments protect public spaces...*, pp. 490–499.

An attack carried out in a place widely perceived as safe and accessible to the public, through which a large number of people pass every day, may result not only in numerous casualties but also in a powerful destabilising effect.

Of particular significance in this context are events of a symbolic nature and of great community value, linked to public holidays, local traditions, religious celebrations, etc.

However, a different level of vulnerability applies to facilities and spaces designed in accordance with the 'security by design' principle. In such locations, security requirements are taken into account right from the planning and design stages, right through to the subsequent operation of the infrastructure. This applies in particular to certain enclosed facilities, stadiums, entertainment arenas and those urban spaces where permanent access control measures have been implemented, along with permanent barriers to vehicle traffic, a clear division of the space into designated security zones, and solutions limiting the possibility of direct vehicle access to areas where large numbers of people are gathered.

This does not, however, mean that facilities designed with safety principles in mind are entirely risk-free. Their vulnerability has merely been reduced through the early identification of threats and the implementation of infrastructural and organisational measures. This distinction marks the boundary between a space that is prepared for a threat and one that remains vulnerable to it, because within the latter, security is treated merely as a reaction to an incident rather than as an integral part of planning.

In practice, this means moving away from the mindset that a vehicle-borne attack is an extreme scenario or one that is possible only in countries with a higher level of terrorist threat. From the perspective of protecting public spaces, what matters is not whether a given country has already experienced a high-profile attack, but whether its public spaces remain vulnerable to such an incident. It is this vulnerability that should be the primary criterion for assessing the need to implement HVM systems.

Delivery vans and lorries in the approx. 7.5-tonne category are particularly realistic element in the design scenarios for this type of threats. This is due to their relative availability, their suitability for use in urban traffic, and their impact energy parameters, which – at the speeds specified in research standards – are capable of causing serious consequences in public spaces. For this reason, the design of safety measures should not focus exclusively on passenger cars, but on scenarios that reflect the perpetrator's capabilities and the geometry of the location[6].

Analysis of the site and access routes as a basis for risk assessment

One of the most important stages in assessing the threat of a vehicle-borne attack is the analysis of a specific site and the identification of all directions from which a vehicle could breach the protected area. At this stage, it is determined whether the proposed security measures will address the actual threat or merely a simplified version of it. In this section, ISO 22343-2:2023[7] has been adopted as a reference, together with supplementary expert guidelines concerning risk analysis, approach geometry, vehicle-borne attack scenario and local conditions affecting the effectiveness of VSBs.

Site analysis should comprise at least five steps:

1) identifying the protected area and its functions,
2) identifying all possible access routes,
3) assessing the geometric and terrain parameters,
4) defining a realistic scenario for a vehicle-borne attack,
5) verifying the continuity of the planned line of defence.

Attention should be drawn to main and side access spaces, utility and service routes, emergency access points, parking areas, sections of urban infrastructure that could be used to bypass the main security line, and the characteristics of pedestrian routes, should their layout be exploitable as a vehicle intrusion route. Only after carrying out such an analysis can one proceed to the appropriate selection of VSBs and the organisation of buffer zones.

The ability to bypass or circumvent the security measure is of particular importance. Even correctly selected and configured VSBs will not fulfil their function if the analysis is limited to a single entry direction, leaving

[6] Cf. ISO 22343-1:2023 Security and resilience – Vehicle security barriers – Part 1: Performance requirement...; ASTM F2656/F2656M-20 Standard Test Method for Crash Testing of Vehicle Security Barriers...; *Hostile Vehicle Mitigation ISO 22343-1:2023 NPSA Guidance Note*, https://www.npsa.gov.uk/system/files/documents/npsa-hvm-guidance-note-iso-22343-1-feb-2024.pdf [accessed: 12 IV 2026].

[7] ISO 22343-2:2023 Security and resilience – Vehicle security barriers – Part 2: Application, https://www.iso.org/standard/81415.html [accessed: 12 IV 2026].

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space at the sides through which vehicles can pass. The effectiveness of the security system depends both on the parameters of the device itself and on the continuity of the security geometry across the entire protected area.

It is a mistake to assume that administrative traffic restrictions, such as entry bans, temporary signage, organisational separation or weight limits, in themselves reduce the level of risk. Such measures may serve an organisational and regulatory purpose, but they do not constitute a physical barrier to a perpetrator acting knowingly and deliberately. From an HVM perspective, it is therefore crucial whether the passage was effectively blocked before the vehicle intruded.

The site analysis should cover both the route of potential access roads and their spatial and functional parameters. Factors of significance include, among others, the length of the acceleration section, the width of the carriageway, turning radius, type of road surface, gradient of the terrain, the presence of intermediate obstacles, and the possibility of using ancillary infrastructure as a bypass route. Elements of the terrain's geometry that may appear secondary can, in practice, determine whether a given direction should be considered a possible intrusion scenario.

A proper site analysis involves adopting the perspective of an attacking vehicle and identifying all realistic ways of reaching the protected area. Only such an approach allows for determining the correct deployment of VSBs, defining the line of defence, assessing the need for layered solutions, and identifying points of particular vulnerability.

For this reason, the analysis of the site and access routes should be the foundation, not a secondary stage of the entire safety design process. If it is carried out superficially, incorrectly or piecemeal, even the best safety devices will fail to ensure an adequate level of safety. In HVM systems, an incorrect assessment of the space almost always leads to incorrect safety measures.

In the context of the design stage, it is also appropriate to distinguish between two zones: the speed reduction zone, where chicanes, narrowings and traffic control elements are used to limit the stopping distance, and the target protection zone (vehicle interception zone), where devices certified as vehicle barriers are employed. Elements from the first zone may enhance safety, but they do not replace VSBs in the vehicle interception zone.

Models for the implementation of VSBs, using European countries as examples

An analysis of solutions applied in practice shows that approaches to protecting public spaces against vehicle-borne attacks is highly varied. This stems both from the level of threat assessment and from the experiences of individual countries and cities in terms of security organisation, spatial planning and the implementation of infrastructure solutions. Consequently, there is no single universal security model that can be uncritically transferred between different organisational contexts. However, it is possible to identify practices that point the way towards a more mature, systematic approach.

In the Polish context, Warsaw remains a key point of reference, where VSBs began to be used at selected events and in certain urban areas, including in the area of the Royal Route, which encompasses Krakowskie Przedmieście and Nowy Świat streets[8].

This phenomenon is significant for two reasons. Firstly, it demonstrates a growing awareness of the problem of protecting public spaces from vehicle intrusion. Secondly, it reveals that progress in this area remains incomplete and has not yet led to the implementation of uniform, consistent systemic standards. In practice, this means that individual successful projects do not amount to a mature national model.

The situation is different, for example, in the United Kingdom, where the problem of protecting public spaces against vehicle-borne attacks was recognised at an early stage, both in practical and regulatory terms. A key feature of the British approach is the integration of infrastructural, organisational and legal measures. Security there is not limited solely to the installation of physical barriers. It forms part of a broader system of risk management, organisational accountability and responsibilities arising from the need to ensure safety of public spaces and public events. Furthermore, legal regulations relating to the concept of the 'Protect Duty', known as Martyn's Law, are being developed in the UK[9]. This measure is

[8] See: *Poprawiamy bezpieczeństwo w stolicy. Rozstawiamy bariery antyterrorystyczne i szkolimy z ich obsługi* (Eng. We are improving security in the capital. We are installing anti-terrorist barriers and providing training on how to use them), Zarząd Dróg Miejskich w Warszawie, 17 III 2026, https://zdm.waw.pl/aktualnosci/poprawiamy-bezpieczenstwo-w-stolicy-rozstawiamy-bariery-antyterrorystyczne-i-szkolimy-z-ich-obslugi/ [accessed: 12 IV 2026].

[9] Cf. Terrorism (Protection of Premises) Act 2025, UK Public General Acts 2025 c. 10, https://www.legislation.gov.uk/ukpga/2025/10/contents; *Martyn's Law: the SIA's New Regulatory*

designed to strengthen protection against terrorism in relation to selected venues and public events by imposing obligations relating to preparation, planning of responses and – in the case of larger venues and events – implementation of proportionate measures to reduce vulnerability to attack. The legal framework does not replace technical solutions here, but assigns responsibility for their assessment and implementation[10].

In Germany, Berlin has become one of the key benchmarks for the security of public events following the attack on the Christmas market in December 2016. This incident led to an increased emphasis on physical security measures in urban spaces and a significant re-evaluation of the approach to the security of seasonal events.

The attack in Nice, France, on 14 July 2016 highlighted the scale of the threat posed by the use of a vehicle in public spaces with very high pedestrian traffic. The cases of Berlin and Nice show that protection of urban spaces in Europe has developed not only on the basis of security theory, but also under the influence of experiences.

In the UK, PAS 68[11] and its associated guidelines serve as an important point of reference. From 2023, the current international standard for vehicle barriers is ISO 22343. In particular, ISO 22343-1:2023[12] specifies test requirements, test methods and the classification of results, whilst ISO 22343-2:2023 relates to the application, selection, installation and use of VSBs in design and operational practice. At the same time, an analysis of publicly available French, Belgian and German materials indicates that, in practice, operational documents, recommendations and organisational solutions concerning the protection of public spaces and public events against vehicle-borne attacks are of primary importance. This does not imply a lack of technical or regulatory solutions, but demonstrates that publicly available materials place greater emphasis on the organisation of security, risk analysis and the selection of security measures than on

Role, Security Industry Authority, https://www.gov.uk/government/publications/martyns-law-the-sias-new-regulatory-role/martyns-law-the-sias-new-regulatory-role [accessed: 12 IV 2026].

10 See: M. Cichomski, *How can local governments protect public spaces…,* pp. 490–492, 497–499.

11 British Standards Institution, PAS 68:2013 Impact test specifications for vehicle security barrier systems, https://knowledge.bsigroup.com/products/impact-test-specifications-for-vehicle-security-barrier-systems [accessed: 12 IV 2026].

12 ISO 22343-1:2023, Security and resilience – Vehicle security barriers – Part 1: Performance requirement…

highlighting separate national crash-test standards. The French General Secretariat for Defence and National Security (Secrétariat général de la défense et de la sécurité nationale) has published a code of good practice on protecting public events against vehicle-ramming attacks; the German Federal Ministry of the Interior (Bundesministerium des Innern) has announced its support for the DIN standard for vehicle barriers, whilst the German police are publishing materials on protecting public spaces against 'Überfahrtaten'. The European Commission under the JRC framework, meanwhile, has published guidelines on the design, testing and installation of protective barriers[13].

The most important conclusion drawn from the analysis of urban models is as follows: the maturity of a system for protection against vehicle-borne attacks stems from the quality of the entire process of selecting barriers within the urban space, their deployment, maintenance and integration into a broader model of organisational responsibility. A city equipped with individual devices is not yet a city with an HVM system. Protection can be described as systematic only when physical measures form part of a previously identified, coherent threat management model.

Event typology and the selection of VSBs

When selecting VSBs, it is important to distinguish between the different types of protected events. Security plans for a recurring or multi-week event, an event involving persons under protection, a mobile event or an event held in a venue unsuitable for large gatherings differ from one another. The type of event influences the route of access, the organisation

[13] Cf. *Se protéger contre les attaques au véhicule-bélier*, Secrétariat général de la défense et de la sécurité nationale, 11 VI 2018, https://www.sgdsn.gouv.fr/publications/se-proteger-contre-les-attaques-au-vehicule-belier [accessed: 12 IV 2026]; *Schutz öffentlicher Räume vor Überfahrtaten*, Polizeiliche Kriminalprävention der Länder und des Bundes, https://www.polizei-beratung.de/themen-und-tipps/staedtebau/schutz-vor-ueberfahrtaten/ [accessed: 12 IV 2026]; V. Karlos, M. Larcher, G. Solomos, *Review on vehicle barrier protection guidance*, Publications Office of the European Union, European Commission, Joint Research Centre, 2017. https://doi.org/:10.2760/845599; *Protection of public spaces from terrorist attacks*, European Commission, Joint Research Centre, https://joint-research-centre.ec.europa.eu/projects-and-activities/protection-public-spaces-terrorist-attacks_en [accessed: 12 IV 2026].

of supplies, the ability to maintain a continuous security perimeter and the requirements for temporary solutions.

Recurring and multi-week events

Recurring events lasting several weeks, such as seasonal markets, are characterised by long-term occupation of the space, regular deliveries and the need to maintain security in the long term. In such cases, it is advisable to aim to create as continuous a security perimeter as possible using certified vehicle barriers, whilst at the same time planning controlled entry points for authorised vehicles.

Events involving persons under protection

Events involving protected individuals, including VIP visits require flexible deployment of security measures along the route and at stopping points. Such operations are characterised by short set-up and dismantling times, the need to move equipment quickly, and the requirement to maintain logistical reserves and personnel ready to relocate barriers between successive locations. Security measures of this type may be implemented on a temporary basis, solely for the purposes of a specific event or a period of heightened risk.

Selected solutions used in European countries are presented below. These solutions differ in terms of design, purpose and resistance to vehicle impact, and their selection should correspond to the type of event, the layout of the security perimeter and operational requirements. Image 1 shows an example of temporary security measures using RBM M30 barriers in a public space in Warsaw during an event requiring a high level of security.

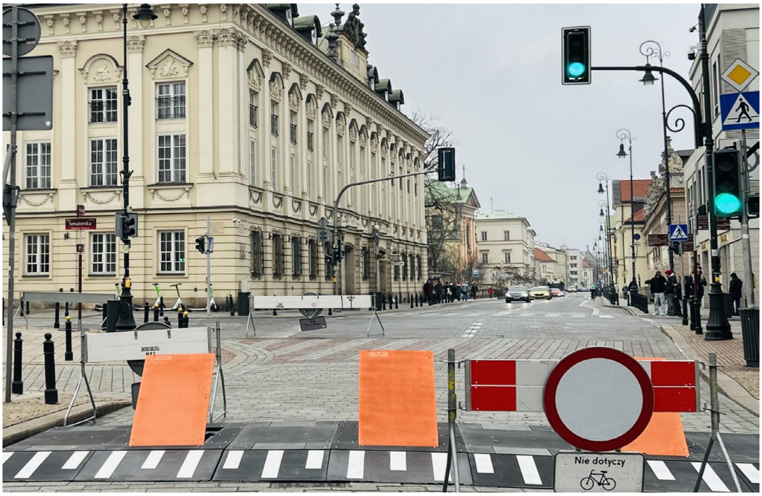

Image 1. RBM M30 barriers – temporary security measures of public space during an event requiring a higher level of security (Warsaw).

Source: DFE Security Sp. z o.o. materials.

Image 2 shows the physical security measures in place at the entrance to the Christmas market in Regensburg, where temporary mobile VSBs have been installed to prevent vehicles from entering public spaces with high concentrations of pedestrian traffic.

Image 2. Temporary mobile VSBs – security measures at the entrance to a Christmas market (Regensburg).

Source: Hörmann Polska marketing materials.

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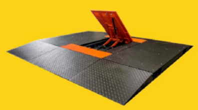
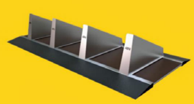
Table 1 sets out selected VSBs used in Europe. They differ in terms of design, purpose and resistance to vehicle impact, and their selection should be tailored to the type of incident, the layout of the security perimeter and operational requirements.

Table 1. Selected VSBs used in the security of public events in Europe.

			
RBM M30	**SURFACE GUARD**	**OKTABLOCK**	**PITAGONE F18**
recurring events, long term road closures	recurring events, long term road closures	one-off, short-term and long-term events	one-off, short-term-events
assembly in 20-minutes (2 people)	assembly: 6 m in 40 minutes (4 people)	no assembly required, setting it up is enough (1-2 people)	quick assembly and the ability to reposition (1-2 people)
transport: lorry with a crane	transport: van	transport: lorry with a crane or a mobile installation crane	transport: van
security level: vehicle weighing 7200 kg – speed 48 km/h	security level: vehicle weighing 7200 kg – speed 32 km/h and 2500 kg – speed 48 km/h	security level: vehicle weighing 7500 kg – speed 55 km/h and 3500 kg – speed 32 km/h	security level: vehicle weighing 7500 kg – speed 48 km/h

Source: own elaboration based on materials provided by DFE Security sp. z o.o.

Mobile events and spaces unsuitable for accommodating large numbers of people

Mobile events, such as motor rallies, and events organised in venues not designed to accommodate large numbers of people require the identification of critical points where a vehicle may reach relatively higher speeds or where the largest number of participants gather. In such situations, it is particularly important to determine in advance the possible routes by which a vehicle could reach the protected zone – that is, potential dredge routes – and to position vehicle barriers in such a way as to prevent the vehicle from continuing its journey towards the area where people are gathered (Image 3).

Image 3. Temporary mobile barrier – security for traffic routes and events held in open spaces (Berlin).

Source: Pitagone marketing materials.

Standards, crash tests and interpretation of the parameters of VSBs

The assessment of VSBs must not be based on the manufacturer's declarations, the product description or engineering calculations alone. Test standards and specifications are of key importance, as they set out the procedures for conducting impact tests, classifying results and comparing different technical solutions. They enable us to determine the specific hazard scenario in which a given device has actually been tested and which of its performance parameters have been empirically verified[14].

[14] See: *Impact Testing of Vehicle Security Barriers. An overview of vehicle impact test standards*, https://www.npsa.gov.uk/system/files/documents/npsa-impact-testing-of-vehicle-security-barriers-18-august-2020.pdf [accessed: 29 III 2026].

An assessment of the device's effectiveness should therefore address the following questions: to which standard has it been tested, for which vehicle category, at what mass, speed and angle of impact, and with what penetration result? Penetration should be understood as the distance the vehicle travels beyond the barrier line following an impact. This parameter allows the required distance between the safety barrier and the protected area to be determined. Without such data, an assessment of the device's suitability is purely declarative.

So called 'engineering solutions' are often found on the market. This term may refer to a structure designed on the basis of knowledge of physics, structural mechanics and soil mechanics, but it is not the same as a device that has been tested in a crash test. An engineering solution can be a valuable stage in the design process, but it does not replace an empirically verified test result[15].

Basic standards used in the assessment of VSBs

The most important documents relating to the testing of devices designed to protect against vehicle-borne attacks include both older national and industry standards, as well as the current international standard ISO 22343. Of historical significance were the American DoS SD-STD-02.01 classifications[16], followed by the British PAS 68 and the IWA 14-1:2013 industry document[17], which standardised the method for testing vehicle barriers and reporting test results. Devices classified according to older standards are still in circulation on the market, which is why familiarity with them remains essential. Currently, the primary reference standard is the aforementioned ISO 22343. Its first part, ISO 22343-1:2023, specifies the test requirements, test method and classification of results, the second part, ISO 22343-2:2023, covers the application, selection, installation and use of VSBs. From a practical point of view, this marks a shift from fragmented, partly national approaches to a more unified assessment

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15 See: *HVM – Vehicle Impact Testing and FEA Computational Analysis Guidance Note*, https://www.npsa.gov.uk/system/files/documents/npsa-guidance-note-hvm-vehicle-impact-testing-and-fea-computational-analysis-15-july-2021.pdf [accessed: 29 III 2026].

16 *Primer on Impact Protection for Critical Transportation Infrastructure, FHWA-HIF-18-054, Federal Highway Administration*, 2018., https://www.fhwa.dot.gov/bridge/security/hif18054.pdf, pp. 17–20 [accessed: 15 VI 2026].

17 IWA 14-1:2013 Vehicle security barriers – Part 1: Performance requirement, vehicle impact test method and performance rating.

framework, which allows for the comparison of solutions assessed under different standardisation systems.

DoS SD-STD-02.01 has not been included in the diagram as a separate standard, as the article adopts a summary approach to the most important standards used in market practice and technical documentation. Its current equivalent in the classification of vehicle barriers is ASTM F2656/F2656M[18] (Figure 1).

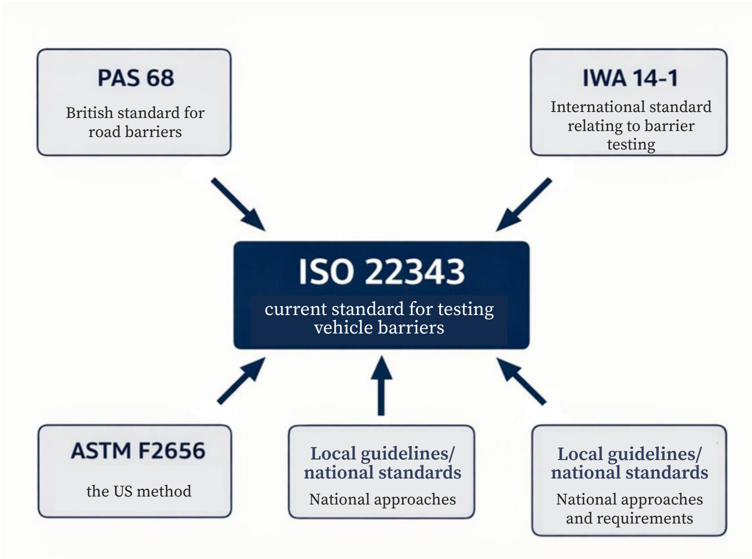

Figure 1. ISO 22343 as the current benchmark for vehicle barrier testing.

Source: own elaboration.

It should be emphasised that PN-EN 1317[19] standard does not apply to VSBs. It is sometimes incorrectly cited in this context, as it relates to road safety barriers. However, it was developed with typical traffic incidents in mind and to mitigate the consequences of road collisions, rather than the threat posed by the deliberate use of a vehicle as a weapon.

18 ASTM F2656/F2656M Standard...

19 PN-EN 1317 Road restraint systems. This standard applies to road systems designed to stop vehicles, such as barriers installed alongside carriageways or between lanes on roads and motorways. The standard relates to road safety and mitigating the consequences of traffic incidents, rather than to VSBs intended to prevent vehicles from being used as weapons.

It is also important to distinguish between an engineering solution and a device that has been tested in accordance with the relevant standard. A mere description of the design or design calculations does not replace a crash test, which is the only way to confirm the device's behaviour under dynamic conditions. From the designer's point of view, it is important not only whether the device stopped the vehicle, but also the test scenario under which it was tested, the mass of the test vehicle, the speed, the angle of impact, the level of penetration, and the secondary effects of the collision.

An analysis of standards should proceed from identifying their origins and scope to answering the question of what the test result means for the actual safety design in a specific location. In this context, PAS 68, IWA 14-1, DoS SD-STD-02.01 and ASTM F2656/F2656M retain historical and comparative significance, while ISO 22343 remains the current international standard.

The article provides an overview of the most important standards still in use in market practice and technical documentation.

Four parameters are of fundamental importance for the correct selection of a VSBs: vehicle mass, impact speed, angle of impact and the level of vehicle penetration. Vehicle mass influences the level of dynamic loads and the impact energy. Speed determines the kinetic energy, and is therefore one of the most important factors determining the behaviour of the vehicle, the barrier and the ground or anchoring system during a collision. Another important supplementary parameter is dispersion, understood as the scattering of debris or vehicle components following an impact. However, it is not a fundamental criterion for barrier selection in the same extent as mentioned earlier, rather, it should be taken into account when assessing the risk to people and infrastructure located beyond the safety line.

The relationship between the angle of impact and the vehicle's trajectory, the barrier line, the penetration zone and the debris zone is shown in Figure 2.

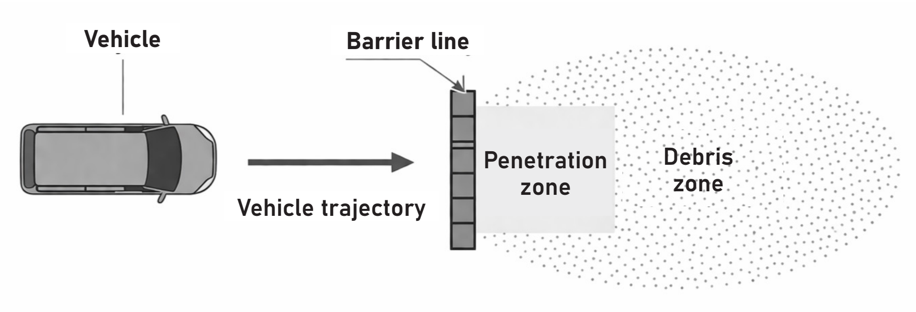

Figure 2. Vehicle collision with a crash barrier, showing the trajectory, the barrier line, the penetration zone and the debris zone.

Source: author's own elaboration.

The angle of impact affects the load-absorption mechanism and determines whether the device operates under conditions similar to those of the tested configuration. Penetration, on the other hand, determines how far a vehicle or its components can intrude beyond the safety line. From the point of view of the safety of those involved in the incident, this parameter is of the utmost importance, as it determines the need to establish a buffer zone. The mere fact that a vehicle has been stopped does not in itself guarantee that the protection is fully effective. If penetration is significant and there are people behind the barrier, the consequences of an incident may still be serious. Therefore, the interpretation of test results must always be linked to planning a safe distance between the VSB line and the space used by event participants[20].

The meaning of the term 'tested device'

In market practice, the term 'tested device' is frequently used, but it is sometimes interpreted too broadly. It does not refer to every commercial version of the device or any installation configuration, but rather that a specific device has been tested in a specific test setup.

The concept of configuration 'as tested' is of key importance in this context. The parameters declared for the device relate exclusively to the specific test setup in which the device was actually tested. Any deviation from this configuration – a change in the angle of installation, the number of device segments, the type of substrate, the connection

[20] See: J. Jaźwiński, *Anti-terrorist protection of public facilities...*, p. 367, 374–376.

system, the method of anchoring or the installation conditions – may lead to a change in the device's operating mechanism and a loss of the parameters confirmed in the test[21].

Crash test records – examples

To understand current testing standards, it is essential to interpret the full VSB classification code correctly. This code is not only a technical code but also provides a concise description of the scenario under which the device was tested.

An example of a code under the older classification system:

IWA 14-1: V/7200[N3C]/48/90:29.1

The individual elements of this entry are as follows: V – vehicle used in the test, 7200 – the vehicle's mass expressed in kilograms, N3C – the vehicle category or type according to the adopted classification, 48 – the impact speed expressed in km/h, 90 – the impact angle expressed in degrees, 29.1 – a parameter relating to the displacement or penetration of the vehicle beyond the barrier's reference line.

An example of a notation compliant with the current standard:

ISO 22343-1: V/7,200(N2A)/48/90:2.6/5.0

In this case, the designations are as follows: V – test vehicle, 7,200 – vehicle mass in kilograms (7200), N2A – category of the vehicle used in the test, 48 – impact speed in km/h, 90 – impact angle in degrees, 2.6 – the value of penetration or displacement of the vehicle relative to the reference line, 5.0 – a parameter relating to the secondary effects of the collision, in particular the dispersion of debris or vehicle components.

The full classification record therefore allows one to determine whether the device has been tested and in exactly which test scenario its effectiveness was assessed. This is particularly important when selecting a device for a specific public space, public event or temporary security measure, as even seemingly similar devices may have been tested under different conditions of mass, speed and impact geometry.

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21 For more on the significance of 'as tested' configurations and the limitations of engineered solutions, see: J. Jaźwiński, *Anti-terrorist protection of public facilities…*, pp. 381–383. See also: *Verifying solutions*, HVMhub, https://hvmhub.com/products-advice/verifying-solutions/ [accessed: 29 III 2026].

From a design perspective, this is a qualitative shift in approach. Protection cannot be assessed solely in terms of 'stopping the vehicle'. Equally important is the question of what secondary dynamic effects the impact itself may generate, and whether the protected space has been designed with these effects in mind. ISO 22343-1 sets out the method for testing and assessing the resistance of a barrier, whilst ISO 22343-2 helps to translate the test result into design and operational decisions. At the same time, neither ISO nor ASTM suggest that the test result alone automatically guarantees effectiveness in all field conditions – factors such as the ground, road surface, approach geometry and specific local conditions remain significant.

Crash test versus an engineering solution

At the design stage, it is possible to develop an engineering solution based on established calculation principles, taking into account material strength, torques, soil mechanics and the method of anchoring. However, this approach does not replace an actual crash test. An engineering solution may indicate how a device is likely to behave, but only a test confirms its actual behaviour under dynamic conditions.

This difference is of fundamental importance. The impact of a vehicle in a collision is not limited to a simple static load on the structure. It involves complex dynamic processes in which factors such as vehicle deformation, the nature of contact with the structure, the distribution of forces over time, the behaviour of the ground, and secondary displacements of components all play a role.

The significance of the research findings for the design of HVM systems

With regard to the design of HVM systems, the results of crash tests are not purely technical or laboratory-based. They form the direct basis for determining the buffer zone, assessing the safe distance between pedestrians and VSBs, selecting the appropriate device for a specific hazard scenario, assessing the secondary effects of an impact, and verifying whether a given solution actually meets the needs of public space safety. In other words, a crash test is not merely a tool for product certification, but above all a source of data essential for the responsible design of safety measures. Without a correct interpretation of the test results, the entire process of selecting VSBs becomes prone to oversimplification, erroneous analogies and the thoughtless transfer of solutions from one location or scenario to another, without taking into account local conditions such as the possible impact speed, impact angle, surface type, method of installation, available buffer space and the nature of the protected area.

Design, installation and operational errors in the use of VSBs for securing public spaces and public events

The effectiveness of VSBs depends not only on their technical specifications, as confirmed by crash tests but also on factors such as the choice of device, its installation conditions, the layout of the space and how the system is used in operational conditions. Errors which can lead to a reduction in the effectiveness of the safety measure, even though the device itself formally meets the test requirements, occur precisely at the interface between these elements. This applies to both permanent safety barriers used in public spaces and temporary barriers used during mass gatherings, recurring events, assemblies and outdoor events. The difference between a crowd control solution and a certified VSB is illustrated in Figure 3.

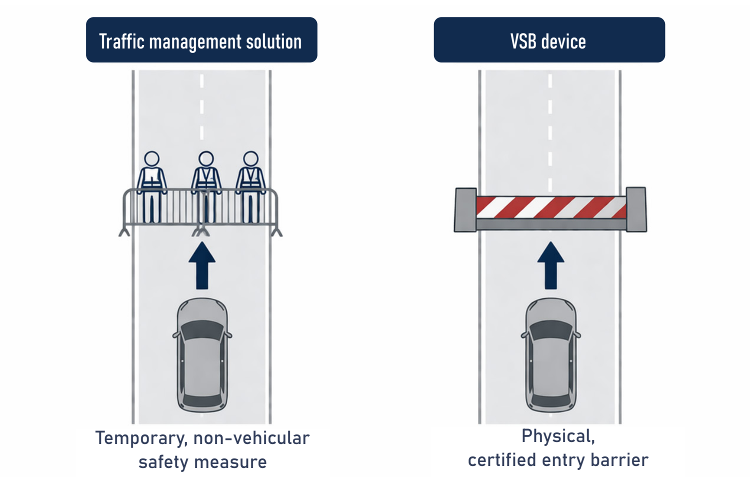

Figure 3. Diagrams illustrating the use of the traffic management solution and VSB.

Source: own elaboration.

Incorrect positioning of the equipment in relation to the access road

One of the key design and installation errors is positioning the device in a configuration that does not correspond to the vehicle's actual approach path. Positioning it at an incorrect angle or along an axis that does not correspond to the vehicle's anticipated trajectory may alter its operating mechanism and reduce the effectiveness of the system. Even a device with excellent performance parameters may not function as expected if it is installed in a spatial configuration different from that for which the security scenario was designed. Particularly advantageous from the point of view of limiting impact energy are those access route layouts in which the vehicle's path is deflected, e.g. at an angle of approx. 90°, and the device is located beyond the bend. Such geometry automatically limits the vehicle's possible speed and makes the safety measure more effective (Figure 4).

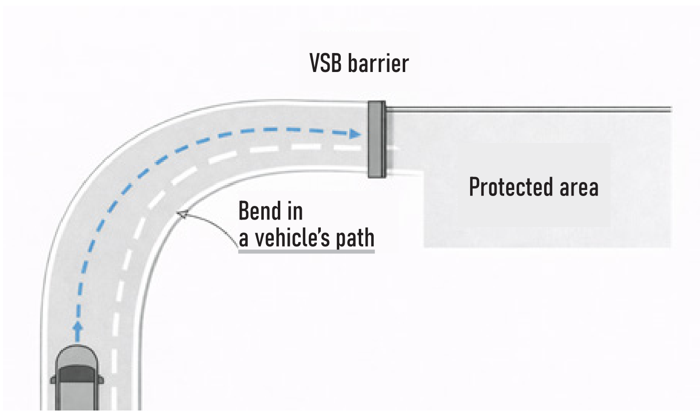

Figure 4. Diagram showing the positioning of the VSB behind a bend in the vehicle's path, restricting the possibility of a direct approach towards the protected area.

Source: own elaboration.

Designing security measures only along the main access routes

One of the more serious systemic errors is to design security measures solely along the main access routes, while leaving side roads, pavements, pedestrian crossings or other areas unsecured. Effective security for a public event requires the designation of a complete security perimeter, i.e. the outer line of the security perimeter marking the boundary of the protected zone, and the identification of all potential access routes, including those that are less obvious, arising from the topography, the proximity of open spaces, and the possibility of access through adjacent green areas. Figure 5 shows a diagram of the security perimeter around the event site, highlighting access routes and the locations of VSBs, including a barrier situated at the boundary with the park area.

In HVM systems, the effectiveness of security measures depends on their continuity and coherence. Individual devices positioned in the most obvious locations do not, in themselves, constitute a security system if the area as a whole can still be breached from another direction. Security must be assessed across the entire perimeter, rather than solely in terms of selected points.

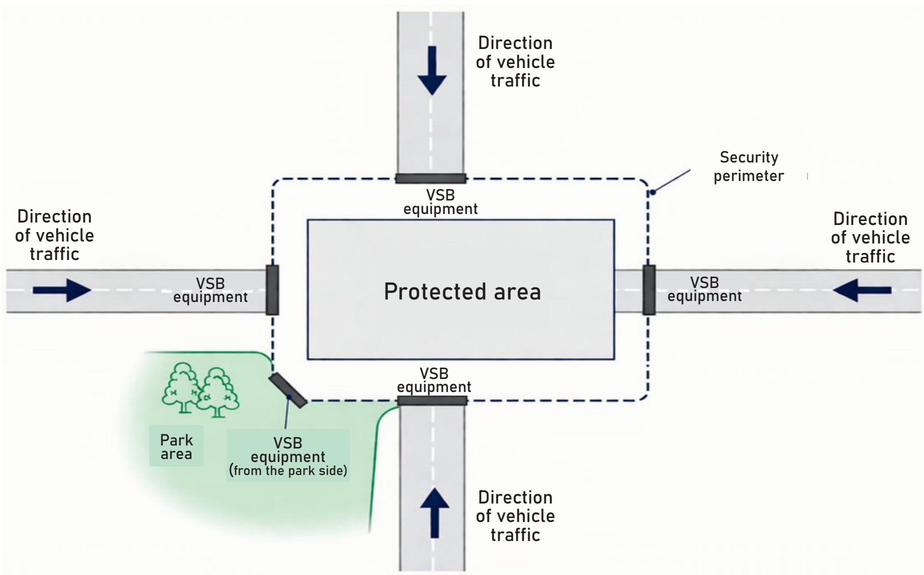

Figure 5. Diagram of the perimeter security zone for the event site, showing access routes and the locations of VSBs, including a barrier at the boundary with the park.

Source: own elaboration.

Installation on an unsuitable surface

A common mistake is to install the equipment on a surface that does not meet the conditions required for its proper operation. In the case of temporary or mobile solutions, the type of surface has a direct impact on the system's stability, friction conditions and the way dynamic loads are transferred during an impact.

The difference between the surface specified by the manufacturer and the surface actually present at the installation site can lead to a significant change in the device's performance, which is sometimes downplayed.

Connection faults in modular systems

In modular systems, the effectiveness of the protection stems from the operation of the entire assembly as a coherent system. One of the more serious installation errors is the failure to connect the segments correctly or the use of an incomplete assembly as specified by the manufacturer. In such cases, this may result in a loss of system continuity, the displacement of adjacent components, or a domino effect. A failure in a single segment can propagate throughout the entire system and lead to a reduction in the effectiveness of the safety measures to a far greater extent than would be indicated by an assessment of the individual component alone.

At public events, this problem is particularly pronounced, as delivery points, technical gates, backstage areas, catering zones, staff access routes, installation prior to the event, and dismantling once it has ended create periods of heightened vulnerability. It is then essential to implement strict access control procedures, temporarily close access points, ensure supervision by security personnel, and clearly assign responsibility for restoring security continuity following each temporary opening of the perimeter.

The lack of a proper buffer zone and failure to take penetration into account

Locating the area designated for event participants too close to the VSBs line is a significant design flaw. A buffer zone must be established behind the safety line. Failing to account for penetration leads to the mistaken belief that the mere presence of the equipment solves the safety issue. However, a vehicle may intrude partially beyond the safety line, and the consequences of an incident may include the displacement of structural components or vehicle parts. For this reason, the buffer zone is one of the fundamental prerequisites for effective protection.

Lack of continuity in security at delivery, service and evacuation points

One of the most common operational errors is failing to ensure the continuity of the security system at locations such as service entrances, delivery points, service access routes, emergency service routes and emergency access routes. Every temporary opening of an access point

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represents a period of increased vulnerability, which must be properly identified and managed.

In practice, it is precisely these areas that often constitute the weakest link in the entire system. If security focuses exclusively on the main perimeter, whilst operational points remain poorly controlled, a situation arises in which security is porous.

The human factor, inadequate skills among installation teams and poor operational supervision

A source of risk that requires particular attention is the human factor. No system will function properly if it is installed incorrectly, without adequate supervision and without knowledge of the technical requirements. This applies both to purely installation-related errors and to the improper operation of equipment during an incident. For this reason, protection based on VSBs requires the involvement of competent installation teams, a clear division of responsibilities and effective operational supervision. Otherwise, even a well-designed system remains vulnerable to operational and organisational errors.

Street furniture and organisational equipment as makeshift security measures

In many towns and cities, it is common to see street furniture such as concrete planters, bollards, decorative blocks or other urban barriers being used as a means of restricting vehicle access to pedestrian zones. Solutions of this type may serve an organisational or regulatory function, but in most cases they do not constitute VSBs (Image 4).

Image 4. Barriers – security measure that is not a VSB (Berlin).

Source: author's archive.

The presence of a physical barrier, passenger car or a city bus, IBC container or lightweight planters is sometimes mistakenly equated with the existence of a genuine security measure (Image 5). Such solutions may temporarily restrict access for organisational purposes, organise the space or force drivers to reduce their speed, but they do not constitute a certified VSB and do not ensure predictable energy absorption parameters in the event of an impact by a heavier vehicle. However, without verified test parameters, without the correct configuration and without reference to a specific threat scenario, such elements merely create an illusion of security[22].

Image 5. An IBC container – element of the traffic management solution that is not a VSB (Poland).

Source: author's archive.

Heavy concrete blocks (barriers) or certified planters with a significant dead weight may form part of a temporary system, but only if their function and method of installation correspond to the adopted hazard scenario. However, they should not be equated with certified VSBs (Images 6, 7).

[22] Cf. J. Jaźwiński, *Anti-terrorist protection of public facilities...*, pp. 367–369; M. Cichomski, *How can local governments protect public spaces...*, pp. 499–507.

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Image 6. Planters – elements of street furniture serving organisational or potentially protective function. Whether they are classified as VSBs depends on their certification and the scenario in which they are used (Rome).

Source: author's archive.

Image 7. Concrete barriers – a solution with organisational or potentially protective function. Whether they are classified as VSBs depends on their certification and the scenario in which they are used (Paris).

Source: author's archive.

Conclusions from the analysis of errors in the use of VSBs

An analysis of design, installation and operational errors leads to the unequivocal conclusion that the effectiveness of HVM systems depends not only on the parameters of the VSBs themselves, but above all on the quality of the entire process of designing, installing and operating the system. This means that even a certified and properly tested device does not guarantee an adequate level of protection if it is incorrectly selected, improperly positioned, faulty installed or used in a space designed without taking the actual hazard scenario into account.

Designing HVM systems in public spaces

The design of HVM systems in public spaces cannot simply involve the placement of individual VSBs in locations intuitively deemed to be critical. An effective protection system requires a sequential approach, in which decisions regarding the selection of devices, the geometry of their placement, the organisation of the space and the manner of use are based on a prior risk and site analyses. Adhering to this sequence determines the difference between real and apparent security.

Risk analysis

Risk analysis should be the fundamental stage in designing a system to protect public spaces against vehicle-borne attacks, which serves as the starting point for determining the type and specifications of VSBs to be used at a given location. Without it, the selection of devices becomes an intuitive process that does not reflect the actual threat.

This analysis should cover at least the following: the nature of the protected area, the profile of the event, the anticipated number of participants, the symbolic significance of the location, possible scenarios for the perpetrator's actions, local traffic conditions, and the potential consequences of a vehicle intrusion. Only by taking all these factors into account is it possible to move from a general assessment of the problem to the formulation of specific security requirements[23].

Analysis of the access route and vehicle-borne attack scenario

The road infrastructure enables a potential attacker to use a vehicle as a weapon. Therefore, an analysis of the access routes leading to the protected area is of fundamental importance for the design of VSBs.

At this stage, it is necessary to determine which vehicles could be used at a given location, at what speed they could reach the protected area, from which directions they could intrude, and what terrain conditions might

[23] Cf. J. Jaźwiński, *Anti-terrorist protection of public facilities...*, pp. 369-372; M. Cichomski, *How can local governments protect public spaces...*, pp. 493–499.

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influence the course of a potential attack. Designing an effective HVM system requires not abstract thinking about a 'vehicle', but the most precise possible definition of the attack scenario involving its use.

Establishment of a protection zone and a security perimeter

Following a risk analysis and an assessment of access routes, it is necessary to designate a protection zone and define the security perimeter. This process involves the deployment of VSBs and the organisation of the space behind the security line. From a security perspective, what lies behind the devices and at what distance from the anticipated impact zone is as important as the positioning of the devices themselves.

The perimeter should be defined comprehensively. Security measures must cover all realistic points of entry, taking into account technical access points, emergency access routes, side passageways and any locations that could be used to bypass the main security line.

Selection of VSBs for a hazard scenario

The selection of devices designed to protect against vehicle-borne attacks should be based directly on the risk analysis and threat scenario. There is no universal VSB suitable for all possible situations. In design practice, one of the most frequently analysed scenarios involves an attack using a vehicle weighing approx. 7.5 tonnes, travelling at a speed of around 50 km/h and 64 km/h, depending on the test standard adopted, the classification of the device and the design specifications. However, the cited model cannot be automatically applied in all locations.

The choice of equipment must take into account the test parameters, the type of surface, the nature of the space (e.g. a town square, a square in front of a stadium, a concert area, an access road, an event's technical facilities, etc.), logistical constraints, installation requirements, the need to maintain passageways and access for emergency services, and the ability to ensure continuous security throughout the event.

Supervision of the installation and organisational responsibility

Before the temporary VSB installation is authorised for use, it can be verified against a checklist. This checklist has been drawn up on the basis of an analysis of the design, installation and operational issues discussed in the article, as well as the author's practical experience relating to the selection and use of vehicle intrusion prevention devices. It consists of:

- compatibility of the device used with the adopted hazard scenario, particularly in terms of vehicle type, direction of impact and anticipated speed;
- compliance of the installation with the 'as tested' configuration, if the declared parameters of the device relate to a specific mounting arrangement, method of connection or type of substrate;
- assessment of the technical condition of the devices and the completeness of the system components, including modular connections and stabilising elements;
- verification of the type and load-bearing capacity of the substrate in relation to the conditions required for the device to function correctly;
- correctness of the alignment of the equipment relative to the access road, taking into account the approach axis, turning radii and the possibility of bypassing the safety barrier;
- continuity check of the safety line to ensure that no gaps or side openings are left between the equipment that would allow a vehicle to enter the protected zone;
- designation of a buffer zone behind the line of devices, taking into account the anticipated vehicle penetration and possible secondary effects of a collision;
- establishment of operating rules for delivery points, service access points and emergency entrances, together with a procedure for restoring the continuity of the safety system following their temporary opening;
- establishment of procedures for authorised vehicles and ensuring that routes remain clear for emergency and security services, whilst maintaining the integrity of the security system;
- acceptance of the installation by a competent person, together with confirmation of the system's operational readiness prior to the start of the event.

For recurring projects, the checklist should include a requirement for a brief training for the technical teams and confirmation of acceptance by a competent person on the part of the organiser or the venue owner. This measure reduces the risk of human error and helps to ensure that the installation complies with the design specifications.

An example of the preparation and training-based deployment of temporary barriers prior to a public event is shown in Image 8.

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Even the best-suited device will not provide an adequate level of protection if it is installed incorrectly. For this reason, the design of an HVM system should include the selection of devices and the organisation of their installation, commissioning and operational supervision.

In European practice, a model is commonly found in which specialist organisations are responsible for both the selection and installation of systems designed to protect public spaces against vehicle-borne attacks. Such solutions have been adopted in the United Kingdom, where a systematic approach to the protection of public spaces is supported by the development of legislation relating to Martyn's Law. The conclusion is clear – an effective system requires not only equipment, but a competent implementation process.

Image 8. Installation of temporary barriers as part of the security preparations for a public event, and a trial placement of barriers (Warsaw).

Source: DFE Security Sp. z o.o. materials.

Zone-based and layered protection

An adequate effectiveness of an HVM system is ensured by an approach known as zonal or layered security. This involves designing security measures in such a way that a breach of one level of protection does not automatically result in full access to the protected zone.

The layered protection may include, among other things, a combination of VSBs, urban planning solutions, access control, traffic management, operational surveillance and the appropriate design of buffer zones.

The advantage of this system lies in the fact that it distributes security from a single line of defence across a sequence of complementary measures.

Evacuation airlocks and controlled access points in permanent and temporary set-ups

One of the more sophisticated models for safeguarding public spaces during public events is a systemic approach in which permanent and temporary security measures complement one another. Such a model can be applied particularly in city centres, on main streets and in squares, where normal traffic flows on a day-to-day basis, while during an event it becomes necessary to temporarily take control of access to the protected zone.

This solution involves equipping the main access routes to the event area with permanent, automatic vehicle barriers, which can be lowered outside event hours to allow normal traffic flow. When event-related procedures are activated, the barriers are raised and take on the role of providing primary protection for the main transport route. At the same time, side streets, underpasses and other potential bypass routes are secured with additional temporary measures to ensure the continuity of protection across the entire zone.

Of particular importance here is the ‘airlock’ solution, understood as a controlled access point for authorised vehicles (Image 9). In this arrangement, a vehicle first enters a designated zone between successive security lines. Once the first section of the barrier has closed, the vehicle may be stopped, verified and subjected to a security check in accordance with the security plan. Only once authorisation has been confirmed is the next section of the passage opened. This solution allows for the simultaneous maintenance of perimeter security, the safe conduct of evacuations, the passage of law enforcement and emergency services, as well as the implementation of vehicle inspection procedures for vehicles entering the event zone. The advantage of this model is its flexibility. The same location can operate in two modes: everyday use and temporary event security.

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Image 9. An airlock solution in an urban setting – a controlled access point and traffic separation point (Berlin).

Source: author's archive.

From a safety design perspective, the airlock model is a particularly valuable, as it combines the requirement for infrastructure resilience with the need to maintain evacuation routes, access for emergency services and access control. Such solutions demonstrate that an effective HVM system does not rely solely on the installation of a single barrier, but on the deliberate design of the entire operational model of the space in the event of an incident (Image 10).

Image 10. VSB – a permanent solution that works in conjunction with traffic management and the protection of public spaces (Frankfurt).

Source: author's archive.

Security by design in the planning of public spaces

The 'security by design' approach is becoming increasingly important in the design of public spaces. This approach involves taking security aspects into account right from the urban planning stage or when organising event spaces. In such a model, developed at European level, security is not an afterthought but an integral part of the spatial design[24]. The earlier security requirements are taken into account, the greater the possibility of harmoniously integrating them with the functionality of the space, the aesthetics of the location and the needs of users. In the context of HVM system, this means the possibility of shaping the spatial layout in such a way as to reduce vulnerability to vehicle intrusion, before such a pressing need arises. Examples of VSBs integrated into a public space is shown in Images 11 and 12.

Image 11. VSBs manually activated – a solution integrated with the public space.

Source: *Unafor. Certified Hostile Vehicle Mitigation with Design in Mind*, Crowdguard, https://www.crowdguard.co.uk/products/unafor/ [accessed: 29 III 2026].

[24] Cf. *Protection of public spaces…*; *Protection*, European Commission, 23 IX 2024, https://home-affairs.ec.europa.eu/policies/internal-security/counter-terrorism-and-radicalisation/protection_en [accessed: 12 IV 2026]; *EU Protective Security Advisors (EU PSA)*, European Commission, https://home-affairs.ec.europa.eu/policies/internal-security/counter-terrorism-and-radicalisation/protection/eu-protective-security-advisors-eu-psa_en [accessed: 12 IV 2026].

Image 12. Temporary mobile VSBs – a solution integrated with the public space.

Source: *ATG Surface Guard*, Crowdguard, https://www.crowdguard.co.uk/products/atg-surface-guard/ [accessed: 29 III 2026].

Final recommendations for the design of HVM systems

When designing HVM systems, it is advisable to follow a few principles. Firstly, the starting point should always be a risk analysis, rather than the choice of equipment. Designing security measures from a product-centred perspective, without first identifying the threat scenario, almost always results in the measures being ill-suited to the site's actual vulnerabilities. In practice, this means that decisions regarding purchase or hire should be secondary to the conclusions drawn from the analysis.

Secondly, a detailed analysis of all access routes and realistic directions from which a vehicle might intrude is essential. Designing security measures solely for the main entrance provides partial protection and is therefore vulnerable to circumvention. For each event, the perimeter should be assessed as a whole, including service roads, footpaths and service routes.

Thirdly, the selection of VSBs should be based on a specific threat scenario, rather than on marketing claims. Test parameters, the 'as tested' configuration, installation conditions and the device's compatibility with the actual spatial layout are of key importance. A product that is unsuitable for the location and scenario does not provide effective protection, even if it has a high test rating in its own right.

Fourthly, the design of protective measures must take into account vehicle penetration and, consequently, the need to define a buffer zone. The safe zone does not begin at the centreline of the device, but only beyond the area of potential impact from the vehicle, its fragments and debris. Omitting this aspect leads to a misleading perception of the level of safety.

Fifthly, an effective system should be layered, spatially coherent and subject to operational oversight. Security cannot rely on a single measure or a single decision-making point. A high level of security is achieved through a combination of infrastructure, procedures, human expertise and the appropriate organisation of space[25].

Sixthly, greater emphasis should be placed on incorporating the principles of 'security by design' into the planning of public spaces and events. The earlier security requirements are integrated into the design of a venue or the organisation of an event, the less need there will be for temporary solutions. In the long term, this approach is more effective, cost-efficient and consistent with a modern approach to risk management.

Local authorities' responsibility for the safety of public spaces in Poland

In the Polish context, local authorities bear particular responsibility for developing systemic mechanisms to protect public spaces. They are responsible for organising many events, managing space and planning expenditure related to safety. For this reason, local authorities should not limit themselves to responding to day-to-day organisational needs, but should establish sustainable HVM/VSB standards for recurring events, plan budgets in advance and draw on the expertise of specialised consultants[26]. It is at local government level that these issues may be institutionalised. Without the involvement of local authorities, the protection of public spaces will continue to develop in a fragmented, reactive manner, dependent on ad hoc organisational decisions. From the point of view of public safety, this model is inadequate.

[25] See: *HVM specifying – some things to consider*, HVMhub, https://hvmhub.com/products-advice/spec-writing-guidance/ [accessed: 29 III 2026].

[26] See: M. Cichomski, *How can local governments protect public spaces …*, pp. 490–492, 505–507.

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The selection of entities involved in the design, supply, installation and maintenance of HVM systems and VSBs is also of significant importance. With regard to public safety infrastructure, it is advisable to use entities with the appropriate authorisations, including a licence from the Ministry of the Interior and Administration, and, in cases involving access to sensitive information concerning security arrangements, system configuration, operating procedures or the identification of vulnerabilities, appropriate safeguards regarding the protection of classified information must also be in place[27]. In certain circumstances, this may mean that an industrial security certificate is required, issued by the Internal Security Agency. This is because the disclosure of information concerning the system's operation, its organisation or installation faults to unauthorised persons may reduce the effectiveness of security measures and increase the vulnerability of public spaces to security breaches.

Summary

The most important conclusion drawn from the article is that protecting public spaces against vehicle-borne attacks requires a systemic approach. It cannot rely on the ad hoc deployment of individual devices or on the use of solutions that are purely regulatory in nature. The effectiveness of the system depends on a combination of risk analysis, the correct identification of access routes, the appropriate selection of VSBs, correct installation, the maintenance of continuous protection throughout the entire secured area, and effective operational supervision.

The issue of protecting public spaces against vehicle-borne attacks in Poland requires further clarification, both in terms of threat assessment and the principles governing the selection, installation and use of VSBs within HVM systems. This applies in particular to the need for wider use of security measures based on research data, technical standards and realistic threat scenarios. Among the most significant problems are

[27] See: *Ochrona informacji niejawnych* (Eng. Protection of classified information), Agencja Bezpieczeństwa Wewnętrznego, https://www.abw.gov.pl/pl/o-abw/zadania/7,Ochrona-informacji-niejawnych.html [accessed: 4 V 2026]; *Bezpieczeństwo przemysłowe* (Eng. Facility security), https://bip.abw.gov.pl/bip/informacje-niejawne-1/nadzor-nad-systemem-oc/bezpieczenstwo-przemys/148%2CBEZPIECZENSTWO-PRZEMYSLOWE.pdf [accessed: 4 V 2026].

insufficient planning of financial resources allocated to the protection of public spaces, the use of standard security measures instead of certified protective devices, and the selection of solutions without reference to vehicle parameters, impact energy and the actual function of VSBs.

The most serious technical errors include leaving side access routes, using standard security devices instead of VSBs, failing to take into account penetrations and the necessary buffer zone, as well as a lack of system continuity at technical and service points. These errors are structural in nature, as they stem not only from a lack of equipment, but above all from an incorrect assessment of the threat and a superficial approach to security.

In this context, it is worth recalling the incident in Sopot in July 2014, when a driver drove a car onto Bohaterów Monte Cassino Street and then onto the pier, injuring many people. This incident was not of a terrorist nature, but it does confirm that the threat posed by the use of a vehicle in public spaces should be taken seriously in the Polish context as well[28].

From an organisational perspective, it is advisable to implement fixed HVM/VSB standards for recurring events, to draw on the expertise of specialist consultants or organisations with expertise in the design and installation of VSBs, and to plan the security budget well in advance. Without such measures, security will continue to depend on ad hoc decisions rather than on a coherent security policy[29].

By way of comparison, it can be said that Poland is currently in a transitional phase. The protection of public spaces against vehicle-borne attacks is increasingly recognised, but is still not being developed in a systemic manner. For this reason, it remains appropriate to draw on the experience of countries that have previously faced such threats and developed more mature legal, organisational and technical solutions, in particular the United Kingdom, Germany and France.

The particular importance of this issue stems from the fact that it concerns not closed infrastructure or solely facilities of strategic importance, but public spaces used by members of the community. Anyone attending a concert, a fair, a sporting event, a religious ceremony

[28] Cf. *Szaleńczy rajd w Sopocie. Kierowca wjechał w grupę ludzi* (Eng. A reckless drive in Sopot. A driver ploughed into a group of people), RMF24, 20 VII 2014, https://www.rmf24.pl/news-szalenczy-rajd-w-sopocie-kierowca-wjechal-w-grupe-ludzi,nId,1471791 [accessed: 12 IV 2026].

[29] Cf. M. Cichomski, *How can local governments protect public spaces...*, pp. 487–492; J. Jaźwiński, *Anti-terrorist protection of public facilities...*, pp. 406–407.

or a gathering in open space may find themselves within the potential impact zone of such a threat.

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