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Security by Design: Protection of public spaces from terrorist attacks.

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Security by Design: Protection of public spaces from terrorist attacks

Contents

Preamble

In recent years, public spaces such as shopping centres, markets, places of worship, public transport and entertainment venues have become the target of terrorist attacks across Europe.

The European Commission is very committed in the fight against terrorism and in providing support to EU Member States to boost their resilience to terrorist attacks and to improving the physical protection of their public spaces. In 2017, the Action Plan to support the protection of public spaces (COM(2017) 612) set out a concrete list of measures to pave the way for an effective EU – Member State cooperation in the protection of public spaces. The 2020 Counter-terrorism Agenda for the EU (COM(2020) 795) seeks to support Member States in better anticipating, preventing, protecting and responding to the terrorist threats. Under its 'protect' strand it also includes measures to reduce vulnerabilities in public spaces including the commitment to issue 'a virtual architectural book on urban design, which can serve as inspiration for authorities to incorporate security aspects in the design of future and the renovation of existing public spaces'.

Drafted with the involvement of a broad range of experts from academia and security experts, this handbook introduces the concept of *security by design* and promotes its practical implementation in the design and redesign of public spaces. It does so while providing information on terrorism risk assessment, project planning / management and proposing innovative technical solutions for the protection of public spaces against terrorist attacks. Security by design is built upon the principles of proportionality, multi-functionality, sustainability, accessibility and aesthetics. Security by design is antonymous to the creation of urban fortresses.

This handbook, which is not legally binding but rather sets out relevant factual information and expert advice, aims at helping address the practical concerns of integrating security measures for project teams, security operators, urban planners and anyone involved in public space projects. It will help readers answering the questions whether and, if yes, to what extent they may wish to implement protective solutions through design.

1   The concept of security by design for public spaces in the European Union

The concept of a public space – a space that is generally open and accessible to people – is central to urban life. Public spaces have always been subject to safety and security concerns, often leading to crime prevention interventions by urban planners in conjunction with law enforcement agencies. However, the regular targeting of public spaces by terrorist groups in the late 20th and early 21st centuries, with the aim of inflicting mass casualties, causing material damage, attracting public attention or enhancing the feeling of public insecurity, has necessitated, among other things, the consideration of protective security in the overall design, or redesign, of public spaces (Coaffee, 2003; Figure 1).

Figure 1: Crowded public space. Source: © jon11 – stock.adobe.com.

The modus operandi of terrorists has become increasingly fluid and transcends national borders (Figure 2). Subsequently, high-profile and lethal attacks targeting public places such as markets, schools, hotels and hospitals, as well as sites of symbolic and iconic value such as places of worship and tourist attractions, ushered in a new era of protective counterterrorist planning in Europe and beyond. Crowded public spaces such as sports stadiums, shopping centres, main streets, hotels and public squares have therefore become a key priority in terms of counterterrorism protection in the EU.
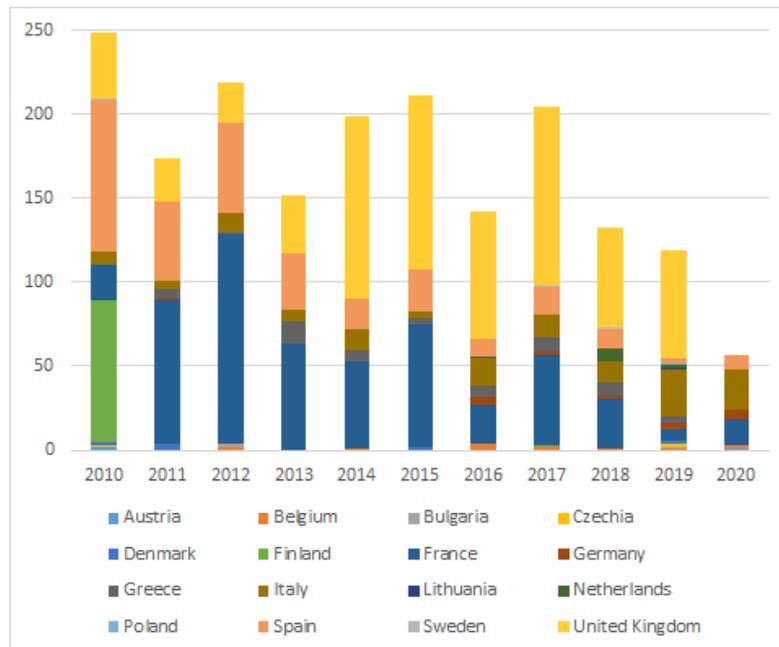
Figure 2: Completed, failed and foiled terrorist attacks in EU Member States between 2010 and 2020 according to the European Union Agency for Law Enforcement Cooperation's Terrorism Situation and Trend Report, based on statistical information on terrorist attacks as reported by EU Member States (https://www.europol.europa.eu/publications-events/main-reports/tesat-report). NB: Data for 2020 do not include the United Kingdom.

The modus operandi of terrorists encompasses tactics such as the use of vehicle-borne improvised explosive devices (VBIEDs), targeting major political or financial centres; the use of person-borne improvised explosive devices (PBIEDs), particularly for suicide attacks; marauding mass shooting attacks, such as the attack in Paris in November 2015; and vehicle ramming attacks that specifically target crowds (Figure 3). These operations typically involve mass casualties or multiple coordinated attacks on crowded public spaces – so-called soft targets – that are considered to represent

vulnerable material assets and which are difficult to protect using conventional means without adversely affecting public access, mobility and civil and individual rights.
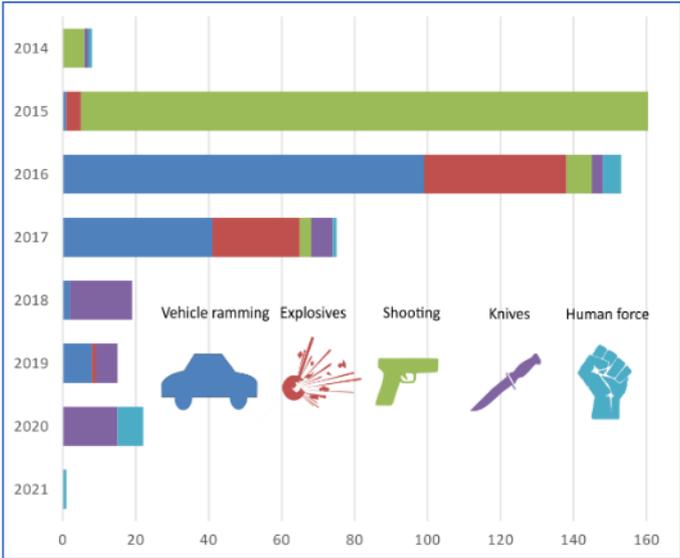
Figure 3: Casualties in the EU from terrorist attacks by year and modus operandi. NB: Data for 2020 and 2021 do not include the United Kingdom.

As part of a holistic approach to protecting public spaces from terrorist attacks, all relevant threats should be considered, as illustrated in Chapter 3. In addition to attacks in which vehicles are used as weapons, these include bomb (improvised explosive device (IED)) attacks. Explosives can be transported by vehicles (VBIEDs), cargo bicycles, drones or people (PBIEDs). Attacks with handguns or with cutting or bladed weapons or similar are not considered in this chapter because they are hard to prevent with structural and other technical measures. The central focus of this book is on mitigating the impacts of vehicle attacks – involving either VBIEDs or vehicle ramming – through innovations in protective urban design. Moreover, it examines whether such designed-in counter-responses (Chapter 4) are proportional to terrorism risk (Chapter 3), with a key focus on the social (Chapter 2), economic (Chapter 6) and aesthetic (Chapter 2) implications.

Public space categories and places of congregation

In the light of the growing number of terrorism threats, a nuanced understanding of what a public space is, is necessary if security is to be part of decision-making in urban design. On the one hand, public spaces such as shopping centres, markets and places of worship (see Table 1) may be populated or crowded only at specific times of the day and/or year. On the other hand, depending on their social and cultural functions, public spaces may either be unchanging or acquire particular significance (e.g. owing to an event or the presence of a VIP). Public spaces may be linked to, managed by or owned by the public or the private sector (Coaffee et al., 2008).

A fixed definition of a public space is intentionally not provided in this book, in order to make the concept as inclusive and as wide as possible. Public spaces are different from critical infrastructure, the latter being, by definition, protected and not freely accessible.

Table 1: Public space categories

Public space category	Places people congregate
Recreational	Stadiums, concert halls, entertainment venues, festivals, parks, markets, shopping malls, theatres, cinemas, nightclubs, restaurants, bars, cultural events, parades, pedestrian zones, etc.
Commercial	Hotels, apartment buildings, office complexes, shops, etc.
Public	Hospitals, medical centres, universities, schools, museums, libraries, etc.
Religious	Churches, synagogues, mosques, religious events, other places of worship, etc.
Transport	Train and subway stations, airports[1], bus terminals, maritime passenger terminals[2], etc.
Governmental	Town halls, ministries, official residences, monuments, landmarks, government office complexes, etc.

Initial protective responses to terrorist attacks

The initial security measures implemented to counter terrorism threats and to manage post-9/11 ([3]) anxieties were predominantly reactive, focusing on the physical robustness and resistance of temporary barriers or engineered security systems, notably security bollards and concrete blocks, which were bulky, visible and not aesthetically pleasing. Highly visible, fortress-like security features were implemented haphazardly in locations that were considered high risk. This drive to secure key locations and assets after 9/11 did, in its rather haphazard and makeshift way, prioritise the security of occupants of public spaces over considerations related to the social, economic or aesthetic conditions or accessibility or transport, often creating a 'fortress' that rather intensified the public's perception of insecurity (Grosskopf, 2006).

London's 'ring of concrete'

The response to 9/11 in urban areas was spatially dependent, reflecting both the history and the geography of different cities and EU Member States. Protective antiterrorism measures were rigorously implemented in London. For example, the US embassy in central London became a virtual citadel, separated from the rest of London by fencing, waist-high 'concrete blockers' and armed guards. ID cards are also required to enter the building. Furthermore, in May 2003, in response to a

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[1] This refers to publically accessible parts of airports (landside, Regulation 300/2008).

[2] Excluding not publicly accessible port facilities in line with subject to Directive 2005/65/EC and Regulation 725/2004.

[3] This refers to the terrorist attacks on 11 September 2001 in the United States.

heightened state of alert regarding a possible terrorist attack given the recent suicide bombings in Saudi Arabia and Morocco, a vast number of waist-high concrete slabs were placed outside the Houses of Parliament to prevent attacks using VBIEDs. This 'ring of concrete' (Figure 4), which was later painted black to make it more 'aesthetically pleasing', was one of several fortifications set up in central London to protect prominent buildings from terrorist attacks.

Figure 4: Rings of concrete. Source: Jon Coaffee.

After repeated attacks using fast-moving vehicles – so-called vehicle-as-a-weapon attacks or vehicle ramming attacks – on crowded locations in Berlin (2016), Nice (2016), Barcelona (2017), Paris (2017), Stockholm (2017), London (2017) and elsewhere, many European cities once again looked to bollards and barriers for additional protection. In many locations, these were placed haphazardly around key sites to prevent further vehicle attacks and/or to reassure the public that the threat of terrorism was being taken seriously by public authorities.

Such ad hoc and supposedly temporary security measures led, in many cases, to **public protests** amid complaints that imposing such security architecture made public places resemble military checkpoints and were an overreaction to the ongoing threat of attack that enhanced public insecurity (GCDN, 2018).

In many cases, ad hoc security barriers that were installed to block vehicle attacks **did not meet the crash-rated performance requirements** for protection against vehicle impact. Moreover, in the event of vehicle impact, these barriers, being free-standing, that is not fixed to the ground, **could themselves become projectiles**. In many locations, the anchoring of protective security measures was either impossible or costly, given the presence of underground infrastructure at shallow depth. In addition, overdesigned security measures may lead to obtrusive, aesthetically unpleasant and costly solutions, as shown in Chapters 4 and 6.

Case study: lessons learned from crime prevention through environmental design (CPTED)

Crime and fear of crime can be prevented or substantially reduced by urban planning, architectural design, engineering and urban (area) management. This applies to property crimes such as burglary, theft, pickpocketing and vandalism, fear of crime and feelings of insecurity, and violent crimes in the public domain: fights, assaults, harassment and most probably also certain types of terrorist attacks.

The relationship between design, urban planning and urban management characteristics and the occurrence of crime and fear of crime has been shown by several researchers over the last 60 years (Vollaard and van Ours, 2011; Armitage and Ekblom, 2019). EU projects [4] have also demonstrated

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[4]   The European Cooperation in Science and Technology action Crime Prevention through Urban Design and Planning (COST TU 1203; www.costtu1203.eu) and the EU Horizon 2020 Cutting Crime Impact Project (www.cuttingcrimeimpact.eu).

that **Crime Prevention through Environmental Design (CPTED) ([5])** (pronounced sep-ted) is a feasible and effective approach to reducing crime and fear of crime in both environments being designed and existing environments. A worldwide International Organization for Standardization (ISO) standard (ISO 22341:2021) also uses the term CPTED, while the European Committee for Standardization (CEN) is currently working on new European CPTED standards (CEN/TS 14383-2:2022).

Traditionally, CPTED has been a mix of broad urban- (neighbourhood/city/place) and behaviour-focused (offender/victim/guardian) approaches. It uses a selection of physical, social and organisational/governance measures in a human-centred design strategy. Initially, it predominantly focused on target hardening (locks, bolts and bollards) and control measures (closed-circuit television (CCTV) / sensors and access control). Though this has often proven effective (Farrell, 2013), CPTED has since evolved by introducing aspects such as participation, liveability, social cohesion and multistakeholder collaboration. In accordance with this broader vision, CPTED can be defined as 'a multi-disciplinary approach of crime prevention that uses urban and architectural design and the management of built and natural environments. CPTED strategies aim to reduce victimization, deter offender decisions that precede criminal acts, and build a sense of community among inhabitants so they can gain territorial control of areas, reduce crime, and minimize fear of crime.' ([6])

Nowadays, there is *consensus* about the main principles of CPTED ([7]).

- It is an approach to preventing crimes (including terrorism) and fear of crime.
- It follows a rational risk management approach (complying with ISO 31000:2018).
- It is implemented through a multidisciplinary, multiagency or partnership process (Schubert et al., 2016) in which participation is key.
- It includes design planning and management/maintenance in a particular physical, social and governance/organisational environment (city, neighbourhood, community, transport hub, school/campus or any other place).

Tackling crime – including terrorism – requires an approach that goes beyond protecting a specific place or person. CPTED takes a broader perspective, not only focusing on a high-risk building or person but considering the whole environment (e.g. neighbourhood or city). For example, it may be more effective – instead of simply positioning a bollard in front of the town hall – to redesign the surrounding public space and make it car free. CPTED also considers the long-term effects of an attack, by including the aftermath and sociopsychological consequences (e.g. organising events for the remembrance of terrorist acts and planning ahead for scenarios with potential post-traumatic consequences). One of the main aims of terrorists is to spread terror and fear in society, which demonstrates the importance of considering the long-term consequences for society. Moreover, CPTED also stresses the importance of considering the offender and his or her motivations and social environment.

In conclusion, CPTED can be a helpful tool, as it uses strict certification procedures and combines criminological, psychological and sociological theories with (urban) design, while focusing on concrete actions.

([5]) www.cpted.net
([6]) From the International Crime Prevention Through Environmental Design Association's website (www.cpted.net).
([7]) See also the new version of CEN TS 14383:2:2022 (from WG-2 in CEN TC 325).

The call for integrated design

As mentioned above, traditional approaches to securing public spaces are seen by many as 'disproportionate', given the low likelihood of a serious crime or terrorist incident taking place and the significant impact on the character of public spaces (see Chapter 2). In practice, and in the presence of an escalating threat of urban terrorism, the use of ad hoc 'target hardening' in the form of security barriers and bollards has become the default mode of protection. As a result, such protective security measures that seek to 'design out' terrorism sit uneasily beside urban revitalisation attempts, which increasingly emphasise inclusivity, liveability, accessibility and quality of life. While public space revitalisation schemes have sought to blend security features into the overall design concept to improve the visual appearance of public spaces and/or to utilise security features as a **multifunctional element of design** (see Chapter 4), the cost of such renovations can be prohibitive (see Chapter 6).

Protective measures implemented in the aftermath of terrorist attacks, that is reactive measures aimed at preventing further attacks, can be described as antiterrorist. However, over time, these have started to be viewed as counterterrorist measures, and are part of a more thought-through approach. Such an approach aims to enhance aesthetic continuity and urbanistic integrity and improve strategic coordination among security professionals, planners, designers and other built environment policymakers who can advise about design options and spatial layout (Coaffee, 2020).

Security-by-design concept

In the new millennium, the wish to provide effective, yet appropriate, security against an array of terrorism threats through urban design and planning concepts – referred to at EU level as 'security by design' – has been promoted as a way of better integrating these concepts from the very beginning of the planning and design of public spaces.

Terrorist attacks most commonly target people in public spaces, which are especially vulnerable owing to their open and accessible nature. We should safeguard the open nature of these spaces while at the same time making them more secure through implementing stronger physical protective measures that do not give the appearance of a 'fortress' and still allow people to walk about freely and safely.

Applying the security-by-design concept can render security solutions more effective, more cost-efficient and better integrated both aesthetically and in terms of civic rights. Security by design encompasses four key principles with regard to embedding protective security into the built environment of cities: proportionality, multifunctionality, stakeholder cooperation and design aesthetics.

Figure 5: The components of the security-by-design concept

The protective security measures deployed should be **proportionate** and **appropriate to the risk faced**, in order to minimise disruption to everyday activities and to allow individuals and businesses to carry out their normal social, economic and democratic activities. Furthermore, proportionality is balanced with **necessity**, and the possibility of underreacting or overreacting, as well as the uncertain and unknown nature of the threats, are weighed up when making political decisions. This desire to achieve proportionality while balancing necessity should be further highlighted as part of risk management (Chapter 6) to allow work to be prioritised in reducing the vulnerability of public spaces to terrorist attacks, and to ensure a suitable balance between the effectiveness of security measures and the social and aesthetic appropriateness of the measures.

Case study: lessons learned from previous terrorist attacks, Stockholm, Sweden

The number of terrorist attacks in Scandinavian countries, as in the rest of Europe, is generally quite small. In addition, strong security measures are not as widely accepted as in other European countries. On 7 April 2017, a stolen 12.5 tonne truck was driven at an average speed of 60 km/h into a pedestrian zone in the capital of Sweden, killing 5 people and leaving 14 seriously injured. The attacker managed to drive the lorry for approximately 500 m through a busy pedestrian zone, running over several decorative concrete lions (weighing approximately 600 kg each) that had been placed at the beginning of the street to deter vehicles from entering.

As these concrete lions were not sufficient to protect against such an attack, stronger measures were implemented after the incident. These consisted of bigger and therefore heavier concrete lions and many additional heavy obstacles, such as flower pots and concrete blocks. All these mobile, surface-mounted barriers were placed around the pedestrian zone, as this area was considered most at risk (higher likelihood of an attack and/or potential greater consequences). They were placed in a way that eliminated potential direct attack routes. This arrangement of obstacles can potentially reduce vehicles' impact speed further reducing consequences. The design concept focuses on keeping the city centre open and attractive to the public, while ensuring that delivery services can access the surrounding stores and at the same time minimising the risk of attacks using vehicles as a weapon.

When designing and planning new urban areas, the concept of security by design should be considered and applied where possible, so that optimal solutions can be achieved in terms of **security, cost-effectiveness, multifunctionality and social acceptability**. Most notably, thinking about security at the earliest stage of designing or redesigning a public space may reduce the overall cost of security, and increase its effectiveness and aesthetic quality. This can also allow security

solutions to be amalgamated with other design issues, creating a co-benefit (and co-cost) design outcome. For example, crash-rated street furniture can be used as a barrier to hostile vehicles.

Cooperation among **a host of associated stakeholders**, most notably security specialists, the authorities, the public and built environment professionals, is required in order to make public spaces safer. The wish to protect buildings and spaces from terrorism – **from an early design stage and holistically** – is evident, as is the support from relevant professional bodies to raise the awareness and skills of architects, planners and the police in relation to counterterrorism protective security. **The intention here is to embed protective security as one of the many material considerations in the design of public spaces *as good practice*, and not necessarily as something that is mandatory for planners to act on.** What can be considered mandatory is a robust risk analysis, which should be the basis of informed decisions on whether or not to install security measures in a public space at a given point in time (see Chapter 3 and Chapter 6).

The **design aesthetics and visibility** of protective security measures have become increasingly important, as traditional barrier and bollard solutions have been criticised, or viewed as reactive, obtrusive or possibly inducing civilian fear (see Chapter 2, 'public's perception'). The realisation of the importance of the social acceptability of security measures has led to a wider appreciation that the measures should be as unobtrusive as possible, while finding a balance between subtlety and safety is vital. In response to this challenge, in the early to mid-2000s security features were being increasingly embedded in the streetscape in such a way that, to the general public, they did not obviously serve a counterterrorism purpose. More recent innovations in security design – some of which will be showcased in this book – have increasingly focused on design integrity to ensure that improvements to public spaces are not overtly security focused.

Case study: Schuman roundabout, European Quarter, Brussels, Belgium

The central Schuman roundabout is a public square in the European Quarter in Brussels. It currently functions essentially as a roundabout, serving mainly vehicle traffic. Dedicated pedestrian and cyclist spaces are limited and not of high quality. Currently, users' needs are not consistently addressed.

The objective of the Schuman roundabout transformation project is to create at the heart of the European Quarter a welcoming, cosmopolitan public space whose identity strengthens its symbolic dimension. The project intends to serve as an example in terms of openness and accessibility, with the objective of creating a meeting space for people that is secure against terrorist attacks.

The project's challenge is to combine user, security and traffic requirements in one public space. To enable access for emergency services vehicles, delivery lorries, public transport and vehicles required for specific events, specific technical pass-through solutions should be implemented. The main technical constraint of the project is the lack of depth available for the foundations because of the existing underground infrastructure (metro systems, road and rail tunnels, ducts, pipes and cables, etc.).

Location-specific studies covered a variety of threat scenarios, such as armed attacks with bladed weapons or firearms, PBIEDs or VBIEDs, IED attacks with various alternative delivery methods (e.g. cargo bicycles or drones), vehicle ramming and chemical, biological, radiological or nuclear attacks. This case study only presents selected hostile vehicle mitigation (HVM)/VBIED protection measures.

The security-by-design concept was implemented as much as possible from the beginning of the project. An appropriate mix of multifunctional protective solutions was selected (low walls and planters, street furniture, traffic lights, street light poles, etc.).

Given the limited available foundation depth due to underground obstructions, specific solutions had to be applied (pooling of foundations, telescopic bollards, etc.).

The project has implemented a multitude of solutions depending on the local constraints and the needs of the public space.

These security by design innovations are in line with the **New European Bauhaus**, which is about building beautiful, sustainable and inclusive spaces. **In essence, security by design is about ensuring that security is integrated into the planning and design processes based on informed decisions made by the relevant stakeholders at the appropriate time.** The design process should be collaborative, becoming more inclusive and participatory by including civil society and wider stakeholder groups.

Overall, advancing innovative protective security approaches is a difficult balancing act, but an enormous opportunity remains for the built environment stakeholders to forge new approaches that also address security needs within more comprehensive development schemes. In this regard, if we want vibrant public spaces we should not let excessive and often highly visible obtrusive protective security become the norm. We should instead seek more proportionate ways of coping with urban terrorism, and increasingly embrace blended security-by-design solutions rather than barrier solutions by default.

Key take-aways

Security by design is still a new and developing concept

Protective design concepts at the beginning of the millennium focused on very visible, hardened installations in high-risk locations. Once these were protected, a multitude of non-protected 'soft target' locations became the main focus. This has led to the development of less intrusive solutions that do not focus exclusively on security but consider also other aspects, as represented by the security-by-design concept.

Security by design has multiple benefits

The key principles of the security-by-design concept – proportionality, multifunctionality, stakeholder cooperation and design aesthetics – ensure that security is better embedded into the built urban environment. Therefore, protective security solutions designed with this concept in mind will be better integrated, more effective, more cost-efficient and more socially acceptable.

2 Past and future challenges of public space development

The public spaces of European cities reflect our cultural diversity. They are characterised by a great variety of installations affected by many parameters, such as the climate, the history of the cities, the cities' link with nature, mobility paradigms, and the heritage of political systems and traditions in the forms and materials of the installations.

Beyond this diversity, a common component is also shared by European cities that distinguishes them from cities in other continents:

- their historical sedimentation, with cities often the result of extended development lasting several centuries, and the significant differences between town centres (often characterised by narrow spaces) and suburbs;
- the capacity for public spaces to not merely act as spaces for traffic but also have a multitude of other uses, even embodying certain ideas of democracy (such as the Athenian Agora or the Roman Forum);
- the higher concentration of sites on the UNESCO World Heritage list and, as a result, the higher number of tourists and importance of the tourism sector;
- their identity, which is often related to the quality of certain major public city spaces, such as Las Ramblas in Barcelona, the Champs-Élysées in Paris, Unter den Linden in Berlin, the Ring in Vienna, Wenceslas Square in Prague, the squares in Italian cities and the *cours* of cities in southern France, among others.

Case study: protection through landscaping using 'raised lawns' – design contest, Paris, France

In late 2017, Paris City Hall initiated an international design contest to completely reorganise and rethink the site around the Eiffel Tower. Launched in early 2018, this competition – '*Grand site tour Eiffel: découvrir, approcher, visiter*' ['The Eiffel Tower great site: discovering, approaching, visiting'] – called for resilient, inclusive and environmentally oriented schemes in order to solve the problems of overcrowding, impaired accessibility, insecurity, lack of services and congested gardens affecting visitors' experience of the famous landmark.

In May 2019, it was announced that the London-based practice Gustafson Porter + Bowman had won the contest to upgrade and redesign the public realm space around the Eiffel Tower to boost safety, improve the tourists' experience and reduce queueing around it. The chosen scheme, dubbed OnE, aimed to create 'the largest garden in Paris' and proposed a unifying central green axis centred on the Eiffel Tower. From a security perspective, a series of raised lawns were planned to protect and elevate the landscape while improving pedestrian accessibility and traffic circulation.

This proposal thus represents a public realm improvement plan that sees terrorist threat concerns specifically of hostile vehicles considered in the multilevel landscape and involves a range of planners working with security professionals to advance effective and socially acceptable security solutions.

These unique characteristics of public spaces should be considered a common cultural asset that may be protected, respecting their identity and their history, while considering contemporary issues such as the struggle against global warming, mobility and accessibility, and established uses, including the promotion of heritage and, of course, users' safety.

In European cities, public spaces are an essential part of everyday life, regardless of their size. They are social places that provide opportunities for interaction and support collective living, playing a central role in urban life.

Abandoned in the post-war years in favour of adapting cities to accommodate cars, the great movement to regain urban spaces through the development of public spaces was initiated in Europe in the early 1990s in the cities of Barcelona, Lyon and Strasbourg. This movement has now become widespread in most cities on the European continent.

Case study: restoration and recovery of the Pilotta area, Parma, Italy

The restoration and recovery projects of the Pilotta area in the city of Parma feature structural changes and landscape development with the aim of increasing the use of pedestrian spaces while taking into account liveability and security.

The area's name, Pilotta, derives from the Basque game pelota, played by Spanish soldiers in the **Guazzatoio courtyard**. The area also accommodates the **national archaeological museum**, **Parma's national gallery**, the **Palatine Library** and the **Bodoni Museum** and is of significant importance to the edifices' functions and their historical character. Green spaces, shopping streets, a public marketplace, buildings housing local institutions and public squares surround the entire area, which is referred to as **Piazza della Pace** (Figure 6).

Figure 6: Situation. Source: © OpenStreetMap contributors, CC BY-SA 2.0 license.

After various improvements through transformation and conservation projects over time, the whole area has been subject to an urban space redesign project in the last 5 years. It focused on improving the use of space, while greatly enhancing the visibility of the site's historical nature and architectural beauty.

The area was previously used as a car park, which made it difficult to appreciate its historical and architectural value. It was necessary to adopt new solutions and change the public's attitude towards the functionality, accessibility and security of public spaces.

A series of interventions were implemented, aimed at enhancing the distribution of spaces, regulating pedestrian/vehicle access, adapting pavement materials and installing appropriate protective measures. The result was a complete change in the environment, with improved usability and green spaces, fitting harmoniously into the surrounding urban environment while maintaining its function as a place of culture, beauty and relaxation.

Several security measures were implemented, for example improved video surveillance systems, with training provided for the police force. Physical protective measures, such as street furniture elements (e.g. planters), were installed and positioned in a natural and aesthetically pleasing way to limit vehicle access. In addition, the area's street lighting was improved; the area's function as a museum cluster, or *Polo Museale*, facilitated the installation of recreational lighting artworks by different artists, which contributed to improving the lighting.

The redesign of the Pilotta area, drawing inspiration from the security-by-design principle, has resulted in a public space that is considered a meeting point and that users appreciate and value. The area has improved aesthetically and functionally but is also more safe, secure, usable and liveable.

But let's go back to an essential question: what are the forms of public spaces in European cities today?

Historical evolution of public spaces

European public spaces have adapted over centuries in different ways, according to the paradigms of different periods and the application (or non-application) of geometric principles.

Streets, avenues and boulevards in old cities can form irregular patterns, if they are the result of organic urban growth, or follow regular layouts, if the city was planned. In historical city centres, in particular, streets are characterised by relatively narrow gaps between facades, demonstrating an intimate bond between buildings and public spaces.

Streets, avenues and boulevards reflect a multitude of historical and geographical contexts and particularities: in the cities of southern Europe, the streets were historically narrow to protect those passing by from the heat of direct sunlight, while in northern cities they were narrow to protect pedestrians from wind and cold. Many avenues, boulevards and the like can be traced back to the great urbanisation phases of the industrialisation of the 19th century, with the emergence of new types of wide, green urban spaces, contributing to a more health-conscious vision of urban development. They often fit into a composition logic in which a prominent role is given to urban spaces with the idea that they portray political and economic power. This was particularly the case in the major capitals of European empires in the 19th century (Vienna, Paris, London, Madrid, Berlin, etc.) but also in the 20th century in cities belonging to Central Europe's former communist regimes (Warsaw, East Berlin, Bucharest, etc.).

Squares constitute distinctive locations that are essential structural landmarks in a city. They characterise the city because they are open and larger spaces within a network of public spaces. They are places of convergence, life and gatherings. In medieval cities, squares acted as hubs for exchange and markets.

In a certain sense, squares are open-air spaces, geometrically organised within dense and compact cities composed of irregular streets. Squares often have a variety of uses. They are the place par excellence of pedestrians, as they provide an opportunity for congregation, rest and a place to showcase urban art. Squares can have different dimensions (district squares, city squares or metropolitan squares) depending on the surrounding building layouts (commercial or civic, etc.) and the functions they host (markets, fairs, outdoor sports, etc.).

Parks and green spaces are public spaces characterised by the significant presence of plants and vegetation. Public parks have become widespread in different forms (urban parks on sites with old city walls, urban parks accompanying the urbanisation of new neighbourhoods, etc.) in parallel with urbanisation and urban growth. They are now places of relaxation, leisure and rest for the inhabitants of cities.

New types of public spaces were established in European cities in the second half of the 20th century, following the urbanisation of suburbs and urban reconfiguration operations that coincided with deindustrialisation (the urbanisation of railways and/or industrial wastelands). These new types of public spaces were established on a series of sites, with particular functions or forms. They can

also accommodate new uses, reconsidered in the light of social or environmental challenges. For example, parks may take the form of passageways, indoor public parks, green corridors, 'pocket parks' or school playgrounds open to the public outside school hours.

In addition to these public spaces, we may also consider **infrastructure or buildings** open to the public or welcoming the public as:

- places linked to public transport (airports, train stations, metro systems, etc.) or places of public infrastructure (hospitals, universities and schools, museums and monuments, etc.);
- entertainment venues (stadiums, concert halls, theatres, cinemas, pedestrian zones, restaurants and bars, etc.);
- places of commercial infrastructure (shops, offices, hotels, conference centres, etc.);
- places linked to the administration and the government;
- places of worship.

These spaces are often open to the public only during specific times and/or for specific events. In much the same way, their management can be public, private or even shared between several parties (refer to Chapter 5 for the challenges associated with this option).

Case study: protection of public spaces during end-of-year events, Vienna, Austria

Figure 7: Vienna Christmas market. Source: © sborisov – stock.adobe.com.

Numerous Christmas markets (Figure 7) are hosted in public spaces and fenced-off areas, for example the grounds of palaces such as Schönbrunn Palace, the Belvedere or the Museums Quarter.

Vienna is also well known for Sylvesterpfad, an annual event held on New Year's Eve. Food and drinks stalls and stages for musical performances are distributed along a predefined route through the historical centre of the city. The celebration ends right in the heart of Vienna around St. Stephen's Cathedral. About 700,000 people participate in the event each year.

The security strategy has been elaborated jointly between the police department and the city authorities. Additional measures implemented for this event comprise temporary obstacles to prevent hostile vehicle attacks and the deployment of additional security personnel, including staff of the Viennese police department. All adopted measures aim to avoid frightening the public; for example, barriers are hidden behind or within decorations, such as large Christmas presents.

Integrating security by design into public space development

The development of the various types of public spaces includes, but is not limited to, design choices related to material and coating, urban furniture integration, the distribution of different modes of transport and the presence of vegetation. Such choices go beyond spaces' strict physical layout and concern in particular the following challenges, which are strongly connected to the issue of security.

Aesthetic and functional issues are characterised by organisational choices, materials and coatings, urban furniture and vegetation. Aesthetic issues mainly relate to the arrangement of the planned space in relation to its immediate building and landscape contexts. The design of a public space can offer a strong architectural identity, or, on the contrary, it can be embedded discreetly in built surroundings that offer a strong architectural identity.

Security issues concerning the public space do not escape the dimension of aesthetics. **Protective measures (bollards, benches, walls, grids, etc.) have their own aesthetics and their earliest integration into the design of public spaces is preferable.**

Case study: public square redevelopment, Reumannplatz, Vienna, Austria

Reumannplatz is a public square in Vienna's 10th municipal district. It was redesigned in 2020 as a result of the extension of the U1 metro line to Oberlaa and the removal of the square's tram stop and rails.

As part of the citizens' participation process, discussions were held with the police (*Landespolizeidirektion*) in order to establish credible threat scenarios and their potential consequences for the planning process.

Security measures were constructed to protect the Reumannplatz from vehicle attacks from the direction of Favoritenstraße. This was challenging, as the position of the U1 metro line's underground infrastructure meant that anti-ram, protective, multifunctional barriers could not be anchored deep into the ground. Therefore, a combination of anti-ramming protective measures was used at the square's entrance.

Using three different, spatially offset concrete walls of varying heights, the entrance to the square was redesigned. The walls can also be used for seating or as a playground. Despite their shallow foundations, they meet the technical requirements for protection against terrorist attacks.

The prevailing use of a public space has to be decided through planning. Inclusive and welcoming cities will generally support a diversity of uses when it comes to public spaces, distinguishing the **uses related to short-term mobility from uses related to prolonged length of stay** (play areas, meeting places, sports centres and cultural practices). Moreover, the European tradition of public space planning generally incorporates the idea of promoting non-exclusive planning for the whole community, including the most vulnerable individuals.

Economic challenges

The way in which public space planning is designed is also linked to stimulating (or not stimulating) certain areas of the economy, even though most trading activities are performed inside buildings (market halls, department stores, etc.). However, the design of open areas greatly influences the local economy; consider parking or pedestrian-friendly areas that are alongside shopping streets. It is

important to consider that the 'new' digital economy involves the wide use of public spaces, for example bicycles and scooters for hire that are often located on pavements or in squares.

Security planning is also influenced by the economic and social needs of public spaces. Limiting vehicle traffic may greatly reduce the risk to pedestrians; however, shops should be accessible for deliveries. The timing of such deliveries may be restricted to early in the morning to decrease the risk of potential attacks (in terms of their likelihood and potential consequences; see Chapter 3), and vehicle access may be blocked during peak hours.

Modes of transport within public spaces

In the middle of last century, privately owned motorised transport was favoured over public transport. Today this trend seems to have been reversed: public transport by road or rail is gaining in popularity (exemplified by, for example, the introduction or reintroduction of trams in cities), prompted by the fight against climate change, and urban centres are progressively being transformed into multifunctional pedestrian zones.

Case study: pedestrian zone – commercial retail area, Mariahilfer Straße, Vienna, Austria

Mariahilfer Straße is one of Austria's most frequented shopping streets (with up to 60 000 pedestrian visitors per day). In order to redistribute the available space in favour of pedestrians and limit individual, privately owned motorised transport (cars and motorbikes), the street was transformed in 2015 into a shared 'encounter zone' and its central part was converted into a pedestrian zone.

In response to the developments in Europe's terrorism threat situation and following consultations between the police (*Landespolizeidirektion*) and the City of Vienna (*Magistratsdirektion*), protective security measures were implemented.

The measures were introduced to protect pedestrians in the Mariahilfer Straße from attacks with vehicles approaching from the direction of Getreidemarkt and the peripheral areas of Mariahilfer Straße.

Implementation of the security measures required several challenges to be overcome, including existing design issues with numerous road-mounted installations and the need to respect legal requirements regarding the status of a shared 'encounter zone', that is ensure equal rights for all space users.

Anti-ram protective measures (in this case, the introduction of vehicle security barriers (VSBs) to reduce the speed of approaching vehicles) were combined with other design elements.

In 2018, a planning office was contracted for the redesign of Mariahilfer Straße.

To minimise restrictions for pedestrians, hardened street furniture (partly installed within the existing road space, thus contributing to speed reduction and traffic calming) was combined with security bollards in the pedestrian zone.

Accelerating the transition to sustainable and smart mobility

Transport accounts for a quarter of the EU's greenhouse gas emissions, and this proportion will continue to increase. To achieve climate neutrality by 2050, emissions from the transport sector will require90 % reduction. To contribute to the achievement of this goal, public space planning calls for

the promotion of multimodal and connected mobility. The aim is to encourage the use of alternative modes of transport that are less polluting than private cars. This movement is already under way in many cities, with the use of public transport, cycling and walking, among other alternative modes of transport, promoted through investment in the necessary infrastructure.

Public transport poses additional challenges for the planning of security in city centres, as buses or trams require access to the areas. The impact on the threat of the use of smart mobility (e.g. self-driving vehicles) for public transport is to be assessed further in the future.

Integrating the climate issue into new urban development projects

Climate change adaptation strategies will be needed at different levels to anticipate adverse effects and prevent or minimise damage. These strategies often have an urban dimension, and individual cities have a major role to play in their implementation through reducing greenhouse gas emissions. Action taken to retrofit buildings for energy efficiency, can adapt urban mobility and disseminate circularity principles, which are highly relevant to the **New European Bauhaus**[8] initiative.

This can also translate into the integration of new design principles in public spaces, such as:

- increasing the number of plants and the biodiversity in the space to combat heat island effects and fight (through shading) the effects of overheating;
- integrating water retention and management devices that can be used to combat the effects of flooding;
- favouring clear, reflective coatings to reduce heat absorption.

Many of these approaches can be selected and/or designed in a multifunctional way to serve as a protective measure as part of the security-by-design concept.

Case study: innovative 'green' protective measures against explosions

The **protective effect of plants** during explosions has previously been tested. Certain plants can **reduce the pressure of an explosion wave by up to 60 %**. In addition, water fountains made of ring mesh with running water reduce the pressure of explosion waves by up to 50 %. At the same time, such systems also provide protection against vehicle impact and flying objects.

Considering cross border aspects of public spaces

The cross-border nature of public spaces that exist in the EU, such as squares that in fact are situated on the border between two EU member states exist, for example: Gorizia (IT) /Nova Gorica (SI), Haparanda (SE) /Torneo (FI) should also be take into account by putting in place close coordination mechanisms of the protective measures. The same approach should be taken for cross-border twin cities/towns like Valga (EE) / Valka (LV) or Baarle-Hertog (BE) / Baarle-Nassau (NL) that have shared public/governmental infrastructures.

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[8] https://new-european-bauhaus.europa.eu/

The public's perception of counterterrorism protective measures

Any protection strategy should take into account its effects on the public's perception of the risk of terrorism and their perception of the presence – or absence – of security measures in public spaces. Therefore, it is crucial to reflect on whether the presence of security measures fosters a shared feeling of security or, on the contrary, contributes to building public fear of an imminent threat.

The discussion on social perceptions is bound to be controversial. Perceptions are inevitably personal, as they are influenced by age, gender, income level, education and political views, and are determined by the cultural and social contexts. Moreover, perceptions change as individuals and communities get additional information and interact with others.

For more detailed information on this subject, please refer to extended interviews in the Annex.

Perceptions of (counter)terrorism, security and related fear

One of the most important aspects, from a sociological point of view, of designing protective measures for public spaces is the fact that the calculated risk of a given threat is not directly proportional to people's perceptions of risk and feelings of insecurity and fear. Indeed, while terrorism is a fundamental concern of many, the actual risk of being killed in a terrorist attack in the EU is very low.

In 2017, 44 % of 33 000 European adults interviewed considered terrorism the most important issue faced by the EU. Yet this rather large figure, reflecting a widespread perception of terrorism as a fundamental security threat, is in conflict with real-life events: in the past 20 years, the number of people killed annually by terrorism in Europe has been less than 200. This is much lower than the average fatalities from road traffic accidents (about 20 000–50 000 annually in the past 20 years). Although the risk of a terrorist attack in the EU is relatively low, the phenomenon has a great impact on the way people experience public spaces and the way they live. This means that reducing the risk of terrorist attacks – for instance, by putting up surveillance cameras, bollards, blastproof windows or guards – does not necessarily reduce people's perceptions of the risk, nor does it halt their feelings of insecurity or fear. To make people feel safe, it is not enough to work on reducing the calculated risk; we should also aim to decrease the perceived risk, by taking into account people's views and, consequently, tackling the triggers of their concerns and fears.

City planners and urban developers play a significant role as creators and managers of public spaces. Security solutions have the potential to guide or support human activities, while influencing people's experiences in public spaces with context and connotations. When implemented, an urban project becomes a social space and is defined not only by its functionalities but also by people's perceptions of it. The wish to overprotect the public from terrorism through an urban project can convey feelings of insecurity or create perceptions of 'no go' places. Public spaces reflect the type of society they host and plan on hosting. Even with protective solutions in place, public spaces should convey a sense of peace and harmony; they should not evoke feelings of alarm, isolation, exclusion or fear.

In municipalities, in the private sector and among the public, there are different ways of perceiving protective measures and various opinions on how these should be planned and implemented in public spaces. To a security company, visible protection might seem like the right solution, whereas, from the perspective of an architecture firm, camouflaging security installations in the urban landscape may be a better option. At the same time, citizens may not have strong opinions on

physical counterterrorism measures, despite being aware of the presence of concrete blocks and patrolling guards in their cities. Diverse opinions suggest the impossibility of finding one commonly accepted solution, as perceptions of security will always differ. Working with protective measures requires weighing the different trade-offs and making decisions, such as whether reducing the risk to the lowest possible level justifies the increased financial costs and impact on everyday life; whether measures should be clearly visible or hidden, temporary or permanent and certified or not; and whether the final aim of their implementation is to reduce only the calculated risk or the calculated and the perceived risk.

A city planner ought to recognise the call for a multidisciplinary approach to protect public spaces from terrorism threats. A cohesive community creates a better environment for detecting suspicious behaviour. Working in close cooperation with the police can make a significant difference when assessing the need for, the design of and the installation requirements for protective solutions. This also means involving citizens and communities in the protection of spaces they claim as their own and deepening their feeling of ownership, thereby leading to more sustainable and effective protection. For instance, the municipalities of Lisbon and Seixal in Portugal aim to rehabilitate public spaces by installing drinking fountains and barbecues, creating shaded areas and removing graffiti, thus encouraging greater community participation.

The level of acceptance of counterterrorism protective measures depends on historical, cultural and political factors, and these can be different across communities, cities, regions and countries. Therefore, a city planner should understand the necessity to have a multidisciplinary team involved in the protection of public spaces in all phases of a project.

Case study: foot patrol community policing to promote safer communities, Lisbon, Portugal

A great example of collaboration between the police and local communities is foot patrol community policing in Lisbon, Portugal. This model of policing is based on the desires of citizens and local partners to promote safer communities; and to identify and solve common problems through cooperation based on a relationship of trust. The model involves two police officers foot patrolling the same districts daily and having monthly meetings with local partners and residents. The group's activities are guided by a co-devised annual programme, which addresses problems such as littering, vandalism, discomfort in public spaces, parking, and so forth. Community police officers cooperate with the population, based on the idea that security depends on everyone and that it is rooted in community support. Such a model can be instrumental in informing the terrorism risk assessment process for particular public spaces, as well as in planning and designing protective measures that will not be negatively perceived by the community[9].

Do physical security measures influence the public's perception of the threat of terrorist attacks?

Public spaces should always convey tranquillity and provide security, comfort and vitality to citizens, yet it becomes a challenge to preserve the balance among all these. The way that security measures are designed and integrated into public spaces determines how people perceive them, as reassuring or alarming. Disproportionate measures feed negative social feelings; therefore, there should be a

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[9] See Cutting Crime Impact's video about the Municipal Police of Lisbon with English subtitles (https://www.youtube.com/watch?v=wX0ZPQ9uCyE&t=63s).

balance between protective measures and the impact of these on people's lives. Ideally, protective street furniture should be 'subtly embedded within the cityscape' (GCDN, 2018, p. 7), in proportion to the assessed threat. Protective architecture can be exceptionally in some situations, but this should not be the norm. Feelings and perceptions in urban spaces are triggered both by the environment and by personal experiences. Protective solutions should be subtle, as the effect that barriers or roadblocks and bollards may generate could result in exclusion as well as protection, despite them having been initially created to control traffic (Schindler, 2015).

Solutions should be proportionate; they should ensure protection without obstructing the vitality of the public space, providing both comfort and security.

If aiming to reduce the perceived risk of terrorism, it is too simplistic to merely wonder whether protective measures make people more or less scared. Rather, one would widen the scope and look at the city in a broad context and at the factors that more generally play a role in triggering people's concerns and fears regarding terrorism. People think about and feel afraid of terrorism in very specific places, such as the kinds of places where terrorist attacks have happened before, for example train stations, Christmas markets and airports, or in cramped spaces, perhaps below ground, with a hectic ambience. The scenarios that evoke a fear of terrorism are different from those that give rise to a fear of other types of crime; hence, different strategies are required to address fear of different types of crime. For instance, to reduce the public's fear of a terrorist attack, it would make sense to focus on congested train stations and airports, pedestrian streets, and crowded events. By working strategically, it is possible to make these areas feel less cramped, to brighten them up, to reduce crowding and to add elements that are conducive to a relaxed atmosphere, by drawing people's attention to things other than crowds and the risk of terrorism.

Can awareness raising among citizens reduce fear and insecurity?

Awareness raising may have contradictory effects. On one hand, it can be useful in providing important information on how citizens are supposed to act if there is a terrorist attack and potentially reduce the consequences of such an attack. Indeed, in countries with higher levels of threat, attack scenario drills and awareness-raising campaigns are common, and people cope well with that reality. On the other hand, constant warnings about how to proceed if there is an attack may create feelings of anxiety and fear. However, in places where the terrorism threat is low, the community is not prepared to comprehend terrorism risk and awareness-raising campaigns may be counterproductive, triggering fear instead of encouraging preparedness and providing a sense of security.

Symbols and urban architecture inform people about what could potentially happen in a space and what is acceptable in the space – in sociological terms, they allow space users to interpret the space. Symbols should be clear and easy to understand quickly, as they replace verbal and other forms of non-verbal communication. However, using symbols may be tricky in multicultural cities, as some cultures have different understandings of colours and different interpretations of urban symbols. General information signage, lighting and other ways of guiding behaviour can be instrumental in encouraging people to be more confident in crowded public spaces, helping them not only to avoid becoming victims of everyday crime but also to be better informed on how to react if there is a terrorist attack.

Protective measures themselves should also communicate as little as possible about (counter)terrorism, as this information can add to the already existing array of reminders about the threat of terrorism. Thus, when installing protective measures in public spaces, the core question to bear in mind is what should be communicated through the public space that is created. In their work on security, employees from the Municipality of Copenhagen decided to focus on some of the key values of the city's public spaces (such as green, inviting and open spaces) and tried to develop protective measures accordingly.

There are differences across Europe in how the public perceives security measures, depending on tradition, historical conflicts and the number and scale of terrorist incidents that have taken place.

Towards an integrative approach to public space planning

Urban development processes are always focused on the long term. Therefore, each planning process should have a long-term vision concerning all the issues described above. **From a sustainability point of view, a public space should be designed to last for a long time.** This requires the development of a strong integrative dimension: a relevant issue today could become obsolete tomorrow, yet the design of the public space will remain for years to come. **Therefore, one issue cannot be prioritised over another, and the entire challenge for the designer is therefore to strike a good balance, taking all the issues into account.**

By adopting an integrative approach that consists in implementing multifunctional protective devices, security requirements can be met by a design that stimulates and boosts urban life. **The aim of any layout should therefore be to integrate several logics and uses into a single object, while focusing on aesthetics, durability, simplicity and functionality.**

Urban design planning

The **design of a city district and/or public space** can have a considerable **influence on the perception of safety/security** and actual crime. If a person feels safe, their **quality of life** is always improved. Strengthening the public's perception of security and **preventing crimes in public spaces** are therefore key objectives of urban design and urban security.

Cities may agree on an **urban design order**, which defines specifications for design and security planning. When **exploring the urban environment** of a public space that requires protection, we should consider the following questions.

- What are its main uses (housing, shopping, events, tourism, business, place of worship, etc.) and who are the associated stakeholders (see Chapter 5)?
- Are there any critical infrastructures (e.g. hospitals) in the vicinity?
- Are there any other public spaces that require protection (e.g. prioritisation)?
- What is the surrounding road network like?
- What are its geometric characteristics?

Case study: conflicting outdoor space policies, Rotterdam, the Netherlands

The city of Rotterdam opened its newly designed central station at the beginning of 2014. The design process started in 2004. During that time frame, the new central station was officially designated as a

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vital space, and therefore a permanently high-risk area. During the design process, the so-called safety triangle (the mayor's office, public prosecutor and local police) made the formal decision to take antiterrorism measures in and around Rotterdam Central Station.

Planning security-by-design measures – specifically against terrorism – as part of an ongoing design process comes with conflicting policies regarding:

- the vision of the urban development department with respect to designing outdoor spaces in a 'Rotterdam style';
- designing open public spaces without obstacles;
- the underground infrastructure of cables and pipes;
- permits and legal requirements;
- the access protocol for emergency services, and management and maintenance requirements.

Although developing the security measures was a formal decision, designing and implementing these measures required dedicated process management. Rotterdam learned to work together with a range of stakeholders, including the architects who designed the train station, local business owners and passengers using the train station.

Often overlooked when implementing security measures is the effect of such measures on the public's perception of their security. The public in Rotterdam could see the ongoing process and construction works as reducing the usability open space. The Rotterdam approach was typical of this harbour city: 'let's fix it and do it in an efficient and effective way'.

Surrounding space: the city-as-a-whole approach

Developing a city **master plan** that considers security can guide the efficient implementation of individual, tailored protective solutions. This is commonly referred to as the 'city-as-a-whole approach'. Such a systemic approach involves all stakeholders and creates **synergies**. Often there are private, governmental and municipal sites that require protection within a city, which have different responsibilities, interests and requirements.

It is much more efficient to follow the **city-as-a-whole approach** from macro level to micro level. When planning hostile vehicle mitigation measures in a particular district of a city, one may study the existing traffic conditions, identify vehicle approach routes and consider the overall street network. Based on this information, one can identify potential protective measures and manage pedestrian and vehicle access, among other things.

Case study: security as a component of public space planning, Germany

The requirement to introduce security-by-design aspects at an early stage in the planning process is not new and is implicitly implemented as part of good planning practice in many projects. Security by design may aim to provide protection against both crime and terrorist attacks.

Public spaces have physical and social significance and are freely accessible to all citizens. The perception of security in public spaces plays an important role, as people will make visiting a space part of their daily routine only if they feel safe in that space. The public's perception of security

cannot be increased simply by introducing surveillance cameras and/or visible police street patrols (Belina, 2006; Bornewasser, 2008; Rothmann, 2010; Querbach, 2020). From as early as the 1990s, CPTED approaches have been adopted in Europe and worldwide. However, security by design is not limited to the installation of technology or structural barriers, such as fences and walls. A holistic approach not only considers measures to reduce opportunistic crime but also puts forward proposals to increase public space users' perception of security.

In order to guarantee that both security and crime prevention are taken into account, security-by-design principles should be integrated from the beginning of a project's planning phase to its implementation phase. It is necessary to prepare all security-related aspects of the project in such a way that they are compliant at each stage of planning.

However, the planning process may be complex and involve many, sometimes lengthy, phases. The lack of unified European planning processes results in procedures that vary depending on asset ownership and the municipal urban development objectives. Figure 8 illustrates a planning process used in Germany.
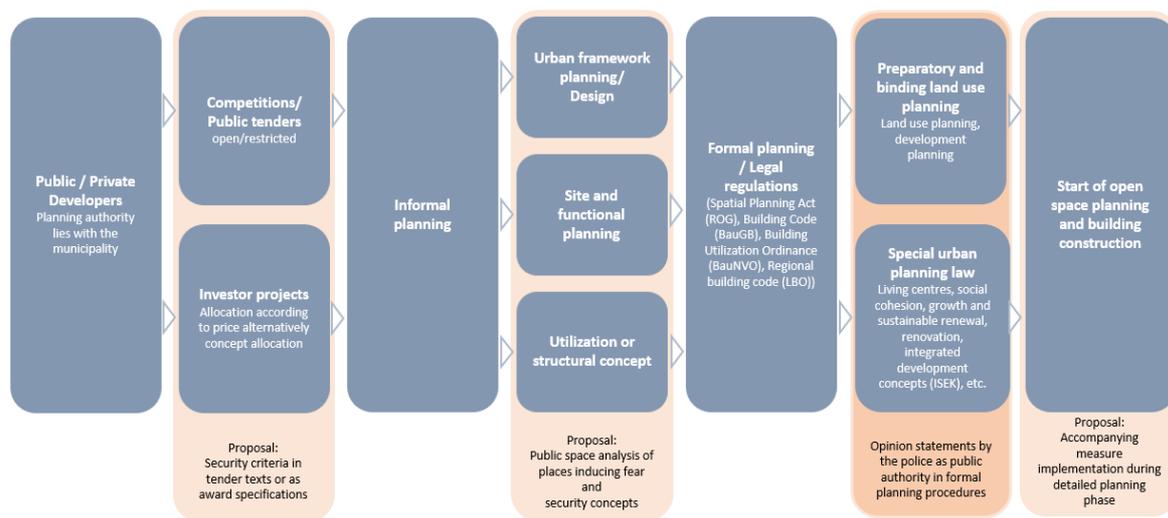
Ways to integrate security by design and protection aspects into planning from the start

Figure 8: Planning processes: the example of Germany

The figure shows that planning processes follow different procedural pathways and legal regulations that may prolong the process. It should also be considered that the initial design project, from the planning to the implementation stage, involves numerous actors from different disciplines with different responsibilities (municipality, building administration, investors, town and space planners, architect, etc.). Therefore, appropriate, well-calibrated security requirements should be formulated and considered at every project stage. For example, security criteria can be considered when drawing up a development plan only if they are legally relevant to planning. Detailed security criteria at the design/planning stage for a building or a public space can be made mandatory in the tender specification (e.g. technical protective measures).

Figure 8 shows that, in Germany, the police, as a public authority, are involved only in the (late)

formal planning phase. This allows the integration of criminal/criminological expertise and insight into structural/spatial effects in the development project.

Therefore, if security-by-design principles are incorporated from the outset, the relevant security aspects are already included in the objectives of the integrated land use and urban development plans and it is strongly recommended that they are part of the competition call. Security criteria can be considered binding for the project developer only if they are properly described. For example, in Lower Saxony, 'Safe Spaces', a tool to aid the planning of public spaces, shows how such criteria can be defined.

The 2020 New Leipzig Charter, setting out best practice for urban planning, considers security by design to be essential to the creation of high-quality public spaces that bring a city to life by creating spaces for meeting, interaction and integration that contribute to the strengthening the public's feeling of security.

In order to achieve these goals, planners and developers need to know what measures are conducive to security and how to structurally prevent opportunistic crime. To this end, the planning principles should be adapted to the various human needs (using different human-centred approaches), which correspond to different functional and design requirements. The design solutions vary according to local circumstances and social composition, which change over time.

| discover | define | develop | deliver | deploy | digest |
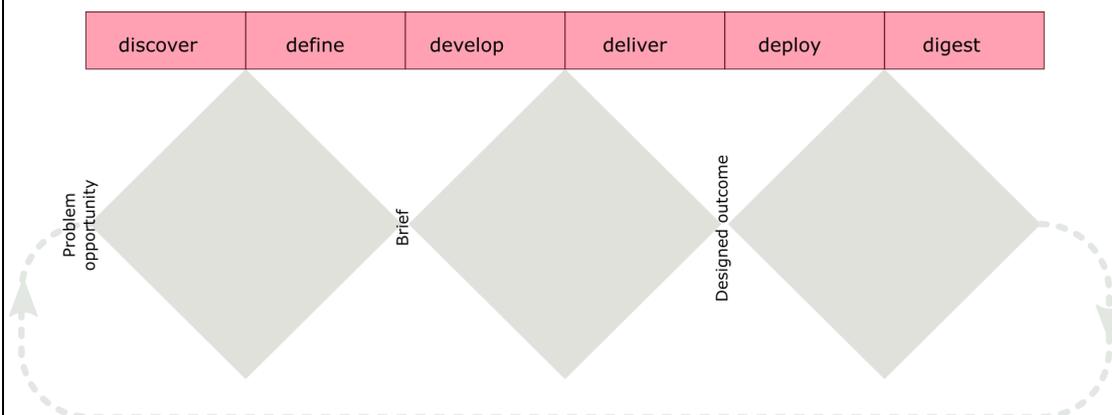
Figure 9: The triple diamond model. Source: Adapted from Davey and Wootton (2011).

It is therefore necessary to **discover** and **define** overall objectives for a new or existing public space (Figure 9). Solutions are selected and **developed** in consultation with the responsible stakeholders. Adjustments deemed necessary can be incorporated at any time during the project.

The human-centred design thinking approach (Norman, 1988; Brown, 2008; Grots and Pratschke, 2009; Davey and Wootton, 2021) can help to increase the security of existing public spaces. A measure can only be successfully implemented if its suitability for use and impact on humans have been sufficiently tested.

Key take-aways

European historic context and changes in public space use over time

The historical character of European cities and changes in public space use over time, particularly in terms of mobility, present challenges in the implementation of security-by-design measures. Therefore, constant adaption of security-by-design measures avoids obsolescence.

Future evolution in line with the European Green Deal

The redesign of public spaces with a view to addressing climate, environmental and biodiversity issues in line with the European Green Deal and the New European Bauhaus initiative provides the opportunity to integrate adapted, multifunctional, protective security measures.

The public's perception of the risk of terrorism risk and other types of crime

The calculated risk of a given threat does not correlate exactly with the public's perception of the risk. To make people feel safe, factors that trigger concern and fear should be considered. Traditional approaches and design tools, focusing primarily on crime prevention, are not necessarily adapted to reduce the public's fear of terrorism.

Consider and adapt to the specific local context

Understanding the local context is crucial because the public's perception of protective security measures in public spaces and terrorism vary widely, change over time and are related to the spaces' history and exposure to past terrorist acts. Protective measures shape a public space's appearance and communicate a message. They may act as a reminder of the terrorism threat but also inform the public about what could reasonably happen, providing guidance on expected behaviour.

Integrative, long-term vision of public space planning, starting with the big picture

Urban development processes should focus on strengthening the integration of all relevant stakeholders by fostering a common long-term vision. A systemic, city-as-a-whole approach from macro level to the specific design of a public space at micro level involves all stakeholders, creates synergies and integrates security-by-design principles from the planning stage through to efficient project implementation.

3   Terrorism risk assessment in public spaces

Previous terrorist attacks in Europe, such as those in Paris (bombing/shooting, 2015), Nice (vehicle ramming, 2016), Brussels (bombing, 2016), Barcelona (vehicle ramming, 2017) and Vienna (shooting, 2020), exposed some of the vulnerabilities of public spaces that can be exploited by murderous individuals and groups. **Even though terrorist attacks are infrequent in Europe, a comprehensive understanding of the parameters that influence their likelihood is required to establish a robust risk assessment and risk management framework.** Independent of their rarity, their direct consequences (e.g. fatalities, injuries and property loss), and even more so their indirect consequences (e.g. psychological, sociological, economic and political), can be disproportionally high. In the worst-case scenario, a terrorist attack could potentially have cascading effects and cross-sectoral impacts; for instance, an attack involving the release of a toxic agent, biological or chemical, could result in a pandemic or environmental disaster.

A risk assessment aims to identify the type of threats that are relevant for an asset, built attack scenarios taking into account potential vulnerabilities and estimate the potential impact of terrorist acts, their severity (for the various scenarios) and their probability of occurrence. Risk management involves the consideration and selection of available options for treating the assessed risk through interventions in different phases, including prevention, mitigation, preparedness, recovery and reconstruction or adaptation.

In this chapter, a structured approach to assessing the risk of terrorist attacks against public spaces is described. Risk management strategies, including appropriate risk treatment options and the acceptable remaining risk, are based on cost–benefit analyses, as will be demonstrated in Chapter 6.

A comprehensive evaluation of terrorism risk entails a large degree of uncertainty, as the collection and management of information regarding threat scenarios or modus operandi, targeted assets, consequences, operational demands and social impact has proven to be a challenge for many authorities owing to their lack of appropriate tools, expertise and resources. The assessment of risk brings about the following questions.

- How is a terrorism risk management plan established?
- How is a terrorism risk assessment process initiated?
- Who is responsible for initiating and performing the assessment?
- What are the best mitigation/deterrence strategies?
- How is the allocation of resources prioritised?

This chapter uses the ISO 31000 (ISO, 2018) definition of risk assessment. Although the definition is generic, it aims to incorporate both natural and human-induced hazards, even if there are difficulties in estimating the likelihood of rare events and the

> **ISO 31000: Risk assessment is the overall process of risk identification, risk analysis and risk evaluation.**

quantification of consequences in the human/social domain. The approach and the techniques proposed here are based on a collection of best practices related to the risk assessment of various hazards/threats.

Lessons learned from prior terrorist attacks

The majority of terrorist attacks on public spaces are carefully planned (or at least planned to a certain degree) to maximise the number of casualties, increase the damage generated and capture the attention of the media and the public (Poljansek et al., 2021). Aggressors usually examine the attack sites beforehand to identify their vulnerabilities and plan their actions[10]. The sites of previous attacks were characterised by the absence of (or insufficient) protective measures to deter an attack or mitigate its consequences. The attacks were unexpected – most of the attackers were not considered a (serious) threat by law enforcement or intelligence agencies – and resulted in human casualties, damages to infrastructure, long-lasting economic losses and sociopsychological impacts.

Previous attacks have demonstrated that terrorists can be highly resourceful in adapting their strategies, in using low-cost tactics and in employing new technologies. Radicalisation and the adoption of extremist ideologies are complex problems in the field of psychology and, depend on social, economic and political factors, both locally and globally. The threat level is not constant and requires regular reassessment, considering new security-related information and reflecting on unforeseen terrorism modus operandi.

Case study: addressing the changing security threat – the case of a luxury hotel, Africa, 2010–2013
The country in which the hotel is situated was subject to an evolving and heightened threat environment in 2010–2013. Addressing the security concerns of its customers and following a risk assessment, the hotel improved its perimeter security by:

- introducing a screening area reaching from the main entrance to the outer perimeter;
- establishing a safe drop-off point for VIPs;
- installing walls offering protection against explosions between the car park and the hotel;
- putting in place security guard posts with 24/7 staff presence at all entrance points;
- introducing a security protocol for deliveries;
- increasing the height of the wall around the perimeter.

Retrofitting to improve security proved to be far more expensive than introducing security solutions in the design phase.

In this case, the risk assessment / risk treatment processes included several stages:

- identifying and assessing threat(s) relevant to people and operations;
- identifying the specifics of the threat e.g. modus operandi;
- determining the likelihood and severity of the threat (with emphasis on severity);
- analysing the vulnerability of the site in relation to the threats identified;
- putting in place adequate mitigation measures (the implementation phase).

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[10] The perceived vulnerability of a target is a key factor in determining the intent of terrorists to conduct the planned attack against a certain identified target. The "intent" component, along with the "capability" component, determines the likelihood or the probability of occurrence of a terrorist attack.

Risk assessment

Risk assessment can be regarded as a tool for identifying the kind of threats we should consider (through building attack scenarios and acknowledging target vulnerabilities), their likelihood of materialising and the potential consequences of an attack. The information derived from the risk assessment process feeds into the risk management process and assists in the selection of risk mitigation measures that could be adopted to respond to the assessed risk. Risk is multifaceted, and a certain asset may be affected differently by different threats, which means that effort is required to identify threats that should be managed and those that cannot be managed or are not relevant. The terrorism risk assessment context described here adopts a similar format to ISO 31010 (ISO, 2019), which supports ISO 31000, in order to promote the use of uniform, consistent terminology and to aid experts who may have to execute different tasks and consider different threats within the same risk module. Terrorism risk is estimated for each specific threat that is identified for the examined public space. To facilitate the evaluation, attack scenarios are proposed, as will be described later. Figure 10 shows the distinct analysis stages that comprise the risk assessment process.

- **Threat identification** involves identifying potential means and methods of attack and includes the identification of vulnerabilities in the public space against the various threats, the assessment of current protective measures and the production of attack scenarios).
- **Risk analysis** includes assessing the likelihood and consequences of the occurrence of the identified threats.
- **Risk evaluation** includes assessing the level of risk and deciding whether it is acceptable or not.
- **Risk treatment** includes describing potential options for reducing the assessed risk.
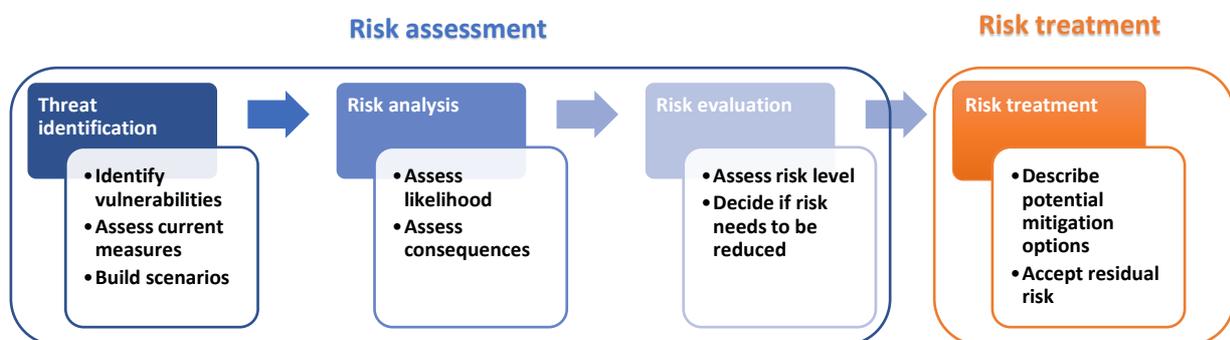
Figure 10: Stages of risk assessment

The results of the risk assessment may differ substantially depending on the background and the goals of the expert who is performing the assessment. If there are insufficient data to evaluate the threat, experts may adopt qualitative methodologies and use their own judgement to assess the risk. However, quantitative risk methods, such as cost–benefit analysis (CBA), are possible if data and/or quantitative assessments are available for threat, vulnerability and consequences (see Chapter 6).

Data related to threat identification (and potentially likelihood) may also be requested from intelligence services and law enforcement units as these organisations have experience in the field and access to sensitive information. Commercial data providers may also have such information, but

they usually lack detail at local level, as will be discussed in more detail later. Even though these data and/or recommendations may be used by the experts to perform their analyses, their quality and availability are not always guaranteed.

Of particular importance is the identification and recruitment of the experts with certain characteristics, such as clear evidence of expertise in conducting terrorism risk assessments, no conflicts of interest, impartiality and an impeccable reputation. Moreover, experts should be aware of their role in conducting the risk analysis, preparing the outcomes and communicating them to the users of the results. These outcomes are usually accompanied by instructions for their precise interpretation by the owners/operators of the public space, who are also responsible for establishing the risk criteria and their acceptable limits.

Threat identification

The first step in the risk assessment process is the identification of the terrorism threats that are relevant to the public space under evaluation. **Threat identification focuses on pinpointing tactics that terrorists may use and on formulating possible attack scenarios.** The identification of human-made threats is a challenging task as, in contrast to natural hazards, available data are scarce and connecting a specific threat to a specific public space encompasses a large degree of subjectivity. Moreover, new terrorist tactics are difficult to foresee, which is why threat trends and information from intelligence services and law enforcement units may prove a valuable resource at this stage. **Threat identification and attack scenario development involve 'thinking the unthinkable'.**

Terrorism propaganda material can provide a source for identifying potential attack scenarios against specific targets, though such information is not easily accessible. Potential terrorist tactics can also be predicted by examining criminal activity in the area of interest. Terrorism-related data sources instrumental for assessing the threat of terrorism include the European Union Agency for Law Enforcement Cooperation's annual EU terrorism situation and threat report, which provides a general overview of the terrorism threat in the EU with facts, figures and an analysis of developing trends, as demonstrated in Figure 11.
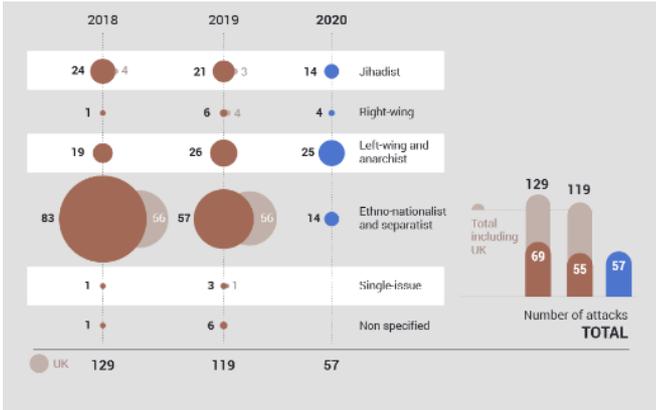
Figure 11: Attacks and arrests in EU Member States in 2020. Source: Europol (2020).

Another source of data that can help assess the risk of terrorism is the European Media Monitor (European Commission, Joint Research Centre, 2021), which analyses information from both

traditional and social media sources. There is a terrorism event database based on this open-source information ([11]), a graphical representation of which is shown in Figure 12.
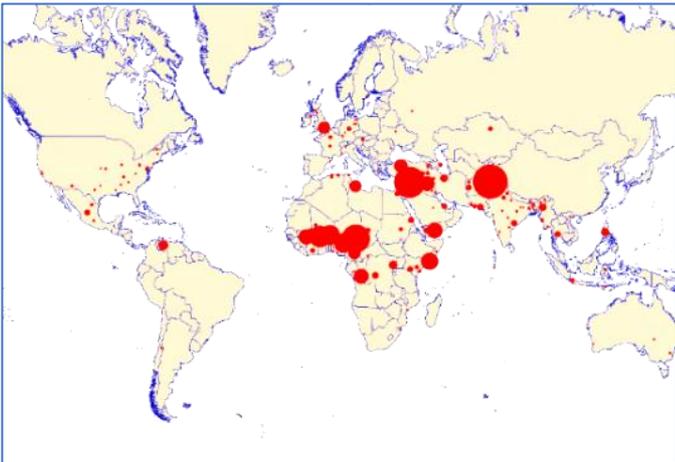
Figure 12: Terrorist attacks in 2020. Source: The Joint Research Centre of the European Commission's terrorism database.

- Commercial security risk data providers, such as Jane's (IHS Markit, 2021) or Control Risks (Control Risks Group Holdings Ltd, 2021) databases, also aid in assessing the terrorism threat.
- Another useful data source is the Global Terrorism Database (University of Maryland, 2018). However, it is updated only annually, so does not include the latest data.

Terrorism threats may change over time, as they are subject to geopolitical and social developments, and liable to follow trends. Threat analysis should therefore focus primarily on the most recent events and tactics.

Additional information supporting the threat identification process, such as the number of firearms in circulation or the terrorism funds obtained through drug trafficking, can be found in organised crime databases. For example, the pie charts presented in Figure 13 show the most common methods of attack and targets worldwide.
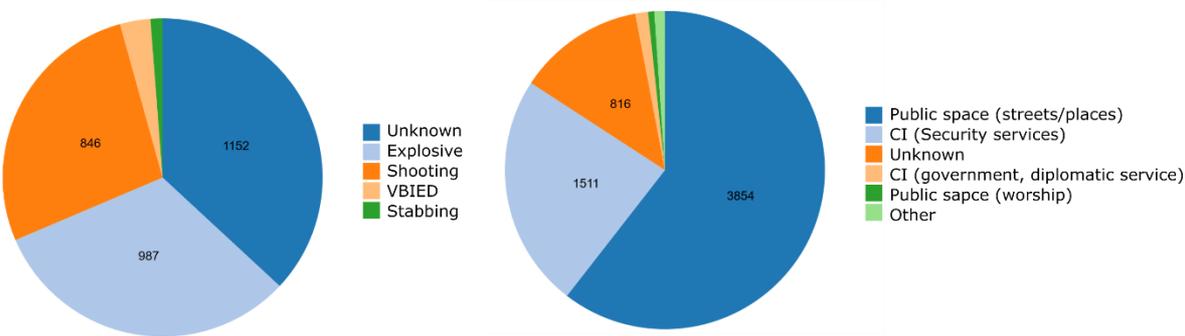
Figure 13: Worldwide terrorist attacks in 2020–2021 by (a) modus operandi and (b) target

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([11])   Contact JRC-PUBLIC-SPACES@ec.europa.eu for additional information.

A note of caution: the indiscriminate use of open-source databases may lead to the overestimation of risk and subsequently the employment of excessive security measures. Such excessive use of security measures may have a negative impact on the feel-good factor of a public space, commercial undertakings or accessibility. The threat identification process should involve law enforcement and the intelligence community as well as the public space's stakeholders.

Assessment of current measures and residual risks

The majority of public spaces lack threat-specific security measures that have been selected and implemented through a systematic risk assessment process. **Security measures, if they exist, should be identified, appraised and improved if deemed insufficient and outdated.** Such a procedure should include both assessment of the performance of the current measures and identification of areas that remain exposed to particular threats. As noted previously, the security threat evolves over the years, so the employed measures may not be appropriate for the increased needs dictated by modern, emerging threats. Existing security measures, if properly applied, can substantially reduce the budget needed to implement new security plans.

Assessing current security measures can reveal residual risks that are present owing to the insufficiency of the adopted solutions and/or poor implementation or operation. Alternatively, the ineffectiveness of current measures may be attributed to unsatisfied technical requirements (e.g. technological limitations), a lack of compliance with the manufacturer's operational guidance, equipment failure, insufficient maintenance of equipment, insufficient operator training, a shortage of personnel, insider threats or other factors, as reported in Chapter 4. Identifying residual risks and evaluating the performance of installed security measures requires the assessor to take a structured approach, which, combined with clear thinking and an in-depth understanding of the safeguards, may lead to clear indications of the measures to be introduced or improved. Failure to comprehend the operation of existing counterterrorism measures may otherwise result in the adoption of duplicate or redundant solutions, which can negatively affect the overall functioning of the security system.

Vulnerability identification

Vulnerabilities are the inherent weaknesses of a potential target that may render it susceptible to the destructive consequences of a terrorist attack. Critically assessing vulnerabilities in the context of attack scenarios will assist decision-makers in taking informed decisions on deterrence and mitigation measures, designing strategies to minimise exposure and developing an effective emergency management plan. A detailed examination of the asset under consideration can identify deficiencies and flaws that may encourage the formulation of an attack plan. Clearly, vulnerabilities are closely related to the main function of each public space.

Attack scenarios are a practical way of illustrating what could occur in the future, and they can prove beneficial, as they allow possible events to be envisaged by making carefully considered assumptions. Building an attack scenario involves describing the incident and the modus operandi of the attackers, considering the general circumstances prevailing at the time of the assault, identifying vulnerabilities and the risk they present and, finally, assessing the potential consequences. Clearly, all attack scenarios are plausible, but they differ in their likelihood of occurrence. Each developed scenario should be as specific as possible, taking into account any measures that are already present,

and be accompanied by educated assumptions that make it easier for the owners/operators to make informed decisions on appropriate actions. Scenarios are unique and may also differ in terms of tactics, severity, extent and impact. They are established for a limited period (e.g. the next 3 or 4 years), as they should be reassessed regularly to consider newly acquired knowledge and trends.

Thoroughly identifying the vulnerabilities of a public space requires the examination of factors such as its accessibility, cultural/religious/symbolic significance, location, shape and existing protective measures (entry checks, video surveillance, security guards, perimeter protection, etc.). The EU vulnerability assessment checklist (European Commission, Directorate-General for Migration and Home Affairs, 2021) provides a set of factors to consider when performing a vulnerability assessment for various types of public spaces. In this checklist, the attack modes in Figure 14 are considered.
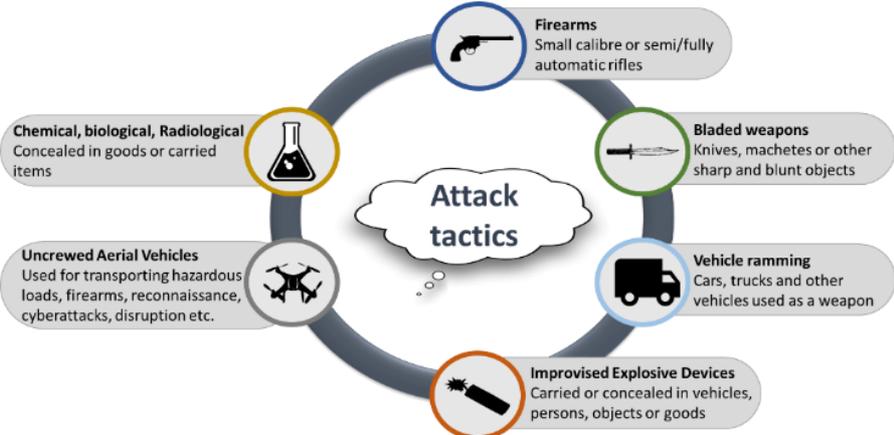
Figure 14: Attack modes against public spaces

To facilitate the development of a rating that reflects potential weaknesses in regards to the abovementioned threats, the assessment of the vulnerability of public spaces can be divided into four phases, as illustrated in Figure 15. The figure includes some of the main considerations that are examined at each step in order to perform a reliable appraisal of the efficiency of existing security measures and to highlight exposed areas that require reinforcement. A more detailed list of factors to be taken into account during the assessment of the vulnerability of public spaces can be found in the EU vulnerability assessment checklist (on request from European Commission, Directorate-General for Migration and Home Affairs, Counterterrorism Unit D2, 2021), which is planned to be transformed into an app. Such an assessment should be assigned to qualified experts who have the expertise required to identify and document these vulnerabilities and eventually provide the data required to assess the criticality of the examined public space in terms of vulnerabilities.

	Surrounding network layout (e.g. bottlenecks, straight/curved/narrow/wide streets, traffic flow) Surrounding facilities (e.g. garages, buildings)	Access to large/heavy vehicles (e.g. VBIED, Chemical attack) Number of access points (e.g. blocked-escape road)
Access roads		
Parking & transport	Parking location and layout (e.g. density of cars, bottlenecks between parking and venue site) Adjacent facilities (e.g. used for performing attacks)	Public transport (e.g. bottlenecks, connection to venue, choke points-people density, peak times)
Entry-exit points	Surrounding area layout (e.g. tunnel, mall) Crowd density and flow (e.g. number of people, peak times, alternative entrances, merging points)	Perimeter security (e.g. measures/responsibility) Access control (e.g. crowd density, vehicle presence) Surrounding traffic (e.g. registered vehicles only)
Site interior	Presence of shelters (e.g. obstacles, stands) Materials causing injuries (e.g. glass ceiling) Insider threats (e.g. staff/suppliers vetting)	Access control (e.g. deception vehicles) Internal security (e.g. random controls, patrolling) Perimeter security (e.g. fences, cameras)

Figure 15: Categorisation of public space vulnerabilities

Likelihood assessment

To determine the criticality and the risk level of a public space, the assessor has to first evaluate the likelihood of occurrence of each identified threat and the potential consequences of an attack. The introduction of a universally applicable methodology for calculating the likelihood of occurrence of a specific threat against a public space is problematic because attacks are frequently opportunistic and insufficient data are available. Moreover, the majority of the information regarding terrorism threats is retained by intelligence agencies, as it is considered sensitive. Nonetheless, decision-makers can conduct better-informed assessments of the likelihood of an attack by considering a number of questions, including, but not limited to the following.

- Are there any indications of an imminent terrorist attack (e.g. threats) at local, regional, national or international level?
- Does the public space represent a religious/ethnonationalist ideology that may be considered a target for the ideological agendas of active terrorist groups?
- Is the target of symbolic, cultural, political or historical value?
- What is the average and the maximum size of the crowd likely to gather in the public space?
- Are any high-profile events hosted in the public space that are attended by famous people, by large crowds or by particular communities or which are covered by the media?
- Are any trained security officials present?
- Are any security measures already deployed (e.g. access control, CCTV, security barriers, perimeter protection or unmanned aerial system countermeasures)?
- How easily accessible are the target's premises and by what means (e.g. vehicles or on foot)?

Empirical formulae for understanding the parameters that influence the likelihood of terrorist events remain limited. Therefore, qualitative methodologies, rather than a precise quantitative evaluation, are commonly used to determine the relative probability of an incident occurring. Such a diagnostic process involves large amounts of subjectivity and bias. To reduce the margin of subjectivity, several

indicators related to the characteristics of both the public space and the examined threat can be introduced (ISC, 2016).

- **Accessibility** is a measure of the openness of the public space and how difficult it would be for terrorists to enter its premises.
- **Threat history** examines information regarding previously reported threats (to the public space or the users) and the crime rate in the surrounding area.
- **Attack complexity** estimates the expertise the attacker would require to perform the attack (e.g. creating an IED, driving a heavy vehicle or flying an unmanned aerial vehicle[12]) and the difficulty in obtaining the weapon or the components for its creation.
- **Importance** depends on the public space's functions, its interdependencies with other facilities and the collateral consequences for the state and the society of a potential attack.
- **People attendance** shows the maximum number of people (personnel and visitors) that are present in the public space during peak hours.
- **Symbolism** is linked to the attractiveness of a public space as a potential target and its probability of being considered as promoting a lifestyle that is against the political, social or religious ideology of attackers. Popular tourist locations, landmarks and cultural sites are also potential targets.
- **Existing measures/vulnerabilities** considers security measures that are already present in the examined public space and may render it less attractive to possible attackers and/or the presence of vulnerabilities that make it more appealing to aggressors.

Figure 16 presents the introduced indicators and the points (1 to 4) to be allocated to each of them. These indicators serve to compare the likelihood of occurrence of an attack against different public spaces with a specific threat that has been identified. If the goal of the analysis is to assess the risk of different threats to a single public space, the indicators that remain unchanged during the development of the attack scenarios (e.g. attendance and symbolism) may be ignored (the threat rating in Table 2 should also be rescaled).

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[12] Two EU handbooks on the thematic of Protection against Unmanned Aircraft Systems will be published in the first half of 2023: the Handbook on Counter-UAS for Critical Infrastructure and Public Spaces as well as the Handbook on Principles for Physical Hardening of Buildings and Sites.
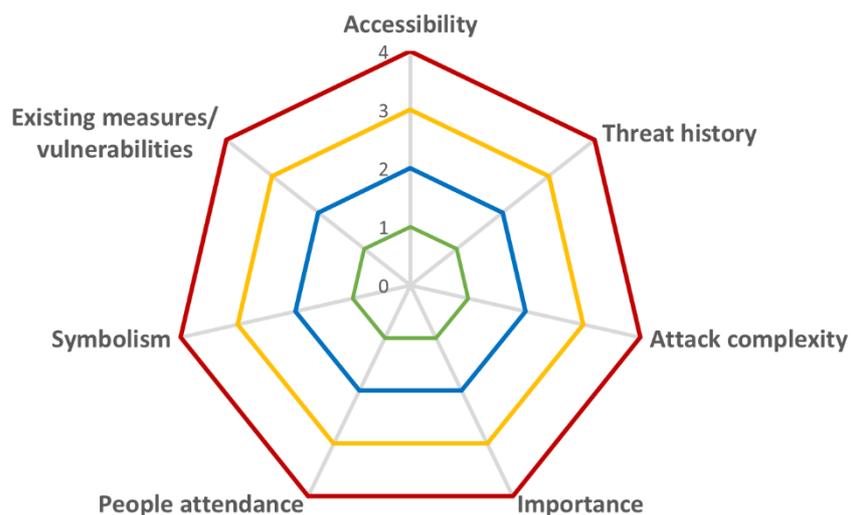
Figure 16: Indicator point system for assessing the likelihood of an attack against a public space

Table 2 shows in detail the scoring criteria to be followed when assigning the points. These scoring criteria do not cover all the different factors that may be used to characterise the likelihood of an attack against a public space. Thus, the aim of this simplified procedure is to facilitate a preliminary terrorism risk assessment of a public space.

Table 2: Scoring criteria per indicator

	Allocated points	1	2	3	4
Indicator	**Accessibility**	• Controlled access • Secure perimeter • Restricted parking	• Controlled access • Restricted parking	• Open access • Restricted adjacent parking	• Open access • Usual presence of protests • Unrestricted adjacent parking
	Threat history	• No previous threats • Past international security incident • Minor-crime	• Some threats • Past national security incident • Low-crime area	• Usual threats • Relatively recent regional security incident • Moderate-crime	• Usual threats • Recent local security incident • High-crime area

	area		area	
Attack complexity	• Advanced technical training required • Very difficult to produce weapon	• Technical training required • Difficult to produce weapon	• Low expertise required • Easy to produce weapon	• No expertise required • Readily available weapon
Importance	• Insignificant impact at national level in the event of an attack • Minor collateral damage (e.g. to adjacent facilities)	• Some impact at national level in the event of an attack • Low collateral damage (e.g. to adjacent facilities)	• Significant impact at national level in the event of an attack • Moderate collateral damage (e.g. to adjacent facilities)	• Very large impact at national level in the event of an attack • High collateral damage (e.g. to adjacent facilities)
People attendance (N)	$N < 100$	$101 < N < 250$	$251 < N < 750$	$N > 751$
Symbolism	• Not well known	• Well known at local level • Iconic only at local level	• Well known at regional level • Iconic only at regional level	• Well known at national level • Iconic at a national level (tourist attraction)

Existing measures/vulnerabilities	• Strong physical security measures • Presence of multiple security guards • Low vulnerability (safeguards, access control etc.)	• Some physical security measures • Presence of limited security guards • Moderate vulnerability (Open facility, protection from current measures is lower than anticipated etc.)	• Basic physical security measures • Absence of security guards • High vulnerability (open facility, facility systems accessible with moderate force etc.)	• Absence of physical security measures • Absence of security guards • Low vulnerability • Very high vulnerability (open facility, facility systems accessible with minimum force etc.)

To determine the threat rating (likelihood of occurrence of each identified attack scenario) of a public space, the points assigned to the abovementioned indicators are added together and compared with the scale provided in Table 3. **This procedure is repeated for each threat to obtain a comparison among the identified threats.** In addition, the credibility and likelihood of each threat is ideally verified by intelligence services and law enforcement units, as they may be able to provide additional information on known threat sources and emerging trends of terrorist activities.

Table 3: Categorisation of threat rating

Threat rating	Most unlikely	Unlikely	Probable	Most likely	Certain
Total score (points sum)	7–11	11–16	17–22	23–25	26–28
Description	Attack unlikely	Low probability of attack	Probable attack	High probability of attack	Imminent attack

Consequence assessment

The consequences of an attack are directly linked to the type of public space targeted by the terrorists and the conditions at the time of the assault. Past incidents have demonstrated that the direct repercussions of an attack range from effects on human life (e.g. injuries or fatalities) to major economic losses (e.g. repair costs and the disruption of services). Indirect consequences are more difficult to assess, as they include social aspects such as the effects on the population's psychology and (indirect) economic costs, for example the impact on the tourism industry.

Consequence assessments serve as a tool for estimating the outcome of different attack scenarios and categorising them according to severity. Despite the difficulty in precisely quantifying several consequences (especially those related to psychological reactions), an evaluation of potential immediate economic losses, property destruction, supply chain disruptions and loss of human lives may facilitate the calculation of the relative value of each public space. To assist in this evaluation process, security officials and decision-makers may want to consider a number of threat-specific questions.

- How many people may be killed or injured during a terrorist attack with the tactic?
- What services may be disrupted if there is a terrorist attack? How long will the disruption last? Are there any backups for the disrupted services? How much will the repairs cost?
- Are there any cascading effects through interconnections with other public spaces or services?
- What are the expected costs of repairing infrastructure damage? Are replacements available?
- Does the examined public space include critical utilities or sensitive information? What are the consequences of their loss or disruption to them?
- Is there a possibility of any political consequences, reputational damage to the organisation/owner and/or security breaches (e.g. personal data breaches)?
- What are the indirect economic costs (e.g. to the tourism industry) and what are the consequences for the population's psychology?

After outlining potential consequences for the public space according to the developed attack scenario, targets can be categorised based on the expected consequences. Table 4 displays the classification of public spaces based on the consequences of a potential attack. The description and severity of the consequences that result in the assigned rating level may differ from those illustrated in the table, as they depend on the type of public space and its significance. It is therefore suggested that the owner/operator of the space should be consulted first.

Table 4: Consequence rating

Consequences	
Insignificant	Negligible consequences No injuries or data leakage No structural damage Small negative reputation

Minor	Minor injuries Short-term disruption of services Minor structural damage Some reputational damage

Moderate	Injuries (no life lost) Medium-term disruption of services Security breach that does not affect normal operations Moderate structural damage (no danger to structure's stability) Significant reputational damage

Critical	Loss of life and serious injuries Long-term disruption of services requiring immediate corrective actions Substantial structural damage (no danger to structure's stability) Security breach that has direct consequences for the operations Extensive negative reputation Higher repair cost

Catastrophic	Extensive loss of life and serious injuries Total loss of services Unacceptable long-term disruption to business operations Extensive structural damage requiring immediate intervention Extensive reputational damage (VIP involvement) Significant political consequences High repair cost

Risk matrices and evaluation

At the end of the analysis phase, the outputs may be communicated in the form of maps, curves, indicators, matrices or other appropriate visualisation methods. The most commonly adopted method is a matrix with the likelihood of the examined threat on one axis and the expected consequences on the other. A matrix used to assess the relevant risk level is shown in Figure 17. Quantitative methods should be used as much as possible to create such matrices in order to reduce the uncertainties of the analysis.

The outcomes of the risk analysis serve as input for comparing the different threats and deciding the types of actions that are required and appropriate. They may also highlight where higher-order (quantitative) methods, such as a CBA, are desirable to help prioritise mitigation options when there is a high level of risk. As the conductor of the risk analysis is usually not responsible for deciding on the required actions, special care is required to properly communicate the results to the decision-makers. Instructions may prove useful to non-experts to help them to correctly understand the results and grasp the overall uncertainty that, inevitably, is a component of the terrorism risk analysis.

Mitigation options

The last step in the terrorism risk assessment process is comparing the results of the risk analysis and identifying potential security measures (if any) that correspond to the previously established attack scenarios and public space vulnerabilities. **Before selecting mitigation measures, an acceptable risk level has to be defined; providing protection against all possible terrorism threats is not feasible in economic or in practical terms.** Terrorism risk analyses, regardless of how detailed they are, entail a certain degree of uncertainty, which means that decision-makers usually have to make a 'judgement call' concerning the protection strategy that should be followed. However, as eliminating the risk is impossible and resources are usually limited, mitigation options require careful review to identify the most favourable cost–benefit combination.

Different responses may be considered depending on the desired outcome and the availability of resources. If the risk is deemed acceptable/tolerable, further actions are not needed. If the level of risk is considered unacceptable, intervention is required. The criteria under which the acceptability of the terrorism risk is evaluated are based on a mixture of social, economic and political factors, which can be very different depending on who is taking the decision. More information on risk management options and risk acceptability/unacceptability can be found in Chapter 6.

Mitigation options should be prioritised based on the abovementioned vulnerability assessment and risk analysis, which can reveal the specific needs of public spaces. The result may be the introduction of new protective measures or the strengthening or repair of existing measures that do not meet the current security demands. Measures may not be limited to structural modifications, but may also include operational actions, such as the introduction of security guards, or the installation of surveillance equipment or other digital sensors, as described by Karlos and Larcher (2020). Such actions may also deter potential terrorist attacks, as aggressors may be discouraged from attacking a well-protected public space (although this may result in the risk being transferred to other neighbouring sites). As mentioned before, there is also the possibility of accepting the assessed risk and the potential consequences, which means that there is no necessity to invest in protective measures.

Security measures may prove costly, affect the built and natural environments, require more resources, influence the population, require regular maintenance, disrupt daily life and pose legal issues. Therefore, an impact assessment, that considers the aspects of practicality and sustainability, may have to be carried out, to guarantee the functionality of the selected measures in the long term. The proportionality of the adopted security measures in relation to the relevant threat and careful planning may drastically reduce the impact of their integration into the security

scheme of a public space. Consideration of security measures at an early stage in project planning, as part of the security-by-design concept, facilitates the promotion of improved aesthetics, higher efficiency and lower operational and installation costs.

Key take-aways

Given the diverse targets and tactics selected by terrorists in their efforts to cause casualties and draw public attention, a holistic and individualised risk assessment approach is crucial for drawing together all terrorism-related data and providing tailored suggestions for effectively reducing and/or mitigating the risk of a terrorist attack.

Call for prioritisation

Protecting all public spaces is an unrealistic goal; a thoroughly designed and carefully executed risk assessment may reveal the sites most exposed to potential terrorist tactics and highlight the vulnerabilities that can be eliminated through the introduction of appropriate mitigation measures.

Characteristics of a risk assessment conductor

Professionals performing the risk assessment should provide clear evidence of their expertise in the field, lack of conflicts of interest, impartiality and impeccable reputation. They are responsible both for preparing the outcomes of the risk analysis and for communicating the results to the owners/operators of the space.

There is no silver bullet in the form of a universal risk assessment methodology

As a universally accepted risk assessment methodology for terrorism threat is still missing, efforts should focus on identifying potential threats using available terrorism databases, evaluating the consequences of potential attacks and assessing the vulnerability of targets. Effective dialogue with the intelligence services can provide inside information on the current terrorism trends and emerging threats that are considered during the risk assessment process, as terrorism-affected zone maps in smaller regions usually lack statistical significance. Assessing the consequences of an attack can also prove challenging, as parameters such as the effect of assaults on public morale or economic damage due to the disruption of services are hard to measure. Nevertheless, certain indicative values can be drawn from prior incidents or even calculated in certain cases (e.g. mortality and injury rates after the explosion of an IED in a crowded place).

Things are changing: calling for periodic reassessment

Finally, terrorism risk is reassessed on a regular basis, as threat types and terrorist tactics change over time. When reviewing the terrorism risk, different factors, such as the global and local political scenes, religious tensions and the availability of potential weapons (explosives, vehicles, guns, biological agents, etc.), are considered. Terrorist tactics should be reconsidered and updated in line with the latest threat developments and, consequently, measures are re-examined to confirm their effectiveness and revised if necessary.

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4 Innovative technical solutions for protecting public spaces against terrorist attacks

Terror attack prevention involves various steps and strategies, such as early detection by intelligence services and the police, security and safety measures, and enhanced coordination/collaboration among relevant authorities. In this chapter, we focus on technical **security measures**, such as **structural** or physical protection against vehicle ramming attacks and explosions. Their establishment should be taken into account from the beginning of a project and follow **urban planning design principles**, thus being an integral part of a building, streetscape, urban environment or landscape. Attacks with handguns or bladed weapons are not considered in this chapter because they are hard to prevent with structural or other technical measures. An overview of available documentation focusing on the protection of public spaces against various malicious threats is provided by Karlos and Larcher (2021).

In order to implement efficient, appropriate and aesthetically pleasing protective security measures, we may take a security-by-design approach, which involves the consideration of security aspects from the outset of a project; a holistic approach (e.g. the city-as-a-whole approach); and an integrated design approach (e.g. aimed at preventing vulnerabilities). Thus, security planning may be regarded as a top-down approach that ranges from the **macro level**, such as the **city-as-a-whole approach**, to the **micro** level, which includes **structural detailing** (e.g. reinforcement and fasteners).

All relevant stakeholders and security practitioners should be involved from the outset of a public space development project, which is one of the main characteristics of the security-by-design concept. Security solutions are often less than ideal if security aspects are considered later and security measures have to be integrated into an existing environment. Such later-implemented solutions may:

- have lower protective capability;
- have greater environmental/aesthetic consequences;
- be less attractive;
- be more expensive.

According to the Urban Agenda for the EU Partnership on "Security in Public Spaces" ([13]), the protection of urban places is driven mainly by the 'hide force concept' (Gebbeken et al., 2018). In this case, an excellent solution is to adopt barriers that blend into the surrounding environment so that they are not recognised as barriers (i.e. invisible barriers). Nevertheless, in the case of the protection of some buildings or places (e.g. embassies or critical infrastructures), a 'show force concept' is preferable.

Case study: stealthy security examples, London, United Kingdom

In response to the challenge of combining robust security with appropriate urban design, crash-rated security features in selective locations were increasingly camouflaged and covertly embedded in the urban landscape so that, to the public, they did not obviously appear to serve a counterterrorism

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purpose. Examples of such 'stealthy' features included ornamental or landscaped installations such as balustrades. These were erected instead of security bollards as part of public streetscape improvements in the government security zone in central London in 2008, in order to make security more attractive and less conspicuous.

Public spaces and their surroundings are so unique that a **one-size-fits-all solution does not exist**. Various site-specific solutions may be assessed to find the security measures that best meet each site's distinct requirements. Thus, we can identify the most efficient solutions at an optimal cost–benefit ratio, as discussed in Chapter 6.

Before implementing security measures, a comprehensive risk assessment is performed for each identified threat, as described in Chapter 3. A risk assessment guarantees that the protective design of a space will be tailored to the risk level in that space, though this does not mean that the protected public space is 100 % secure, as even if technically possible, this would be financially prohibitive'. The employed security plan, which is based on the risk assessment, usually provides a level of protection that does not cover all potential attack scenarios, as a certain risk level may be deemed acceptable.

Hostile vehicle mitigation

Site assessment and speed reduction measures

Protective measures implemented as part of urban planning are always based on a **site-specific assessment** and require individual solutions. Access to a protected space must be ensured for emergency services and law enforcement units in accordance with local needs and legal requirements. Moreover, in city centres vehicle access has to be guaranteed for supply and disposal companies, security service providers, delivery trucks and hotel guests, among others. Access for people with disabilities should also be considered. Traffic demands, along with the envisaged method, layout and location of any access control system, should be carefully considered before selecting a vehicle barrier system (Figure 18), as they greatly influence its required technical characteristics and operational needs. Parking facilities and drop-off zones are considered as potential locations for VBIEDs. Hostile vehicle mitigation measures that **do not meet the necessary technical specification** (incomplete line of barriers, incorrect spacing, different levels of protection, etc.) may give an attacker the opportunity to access a protected space.
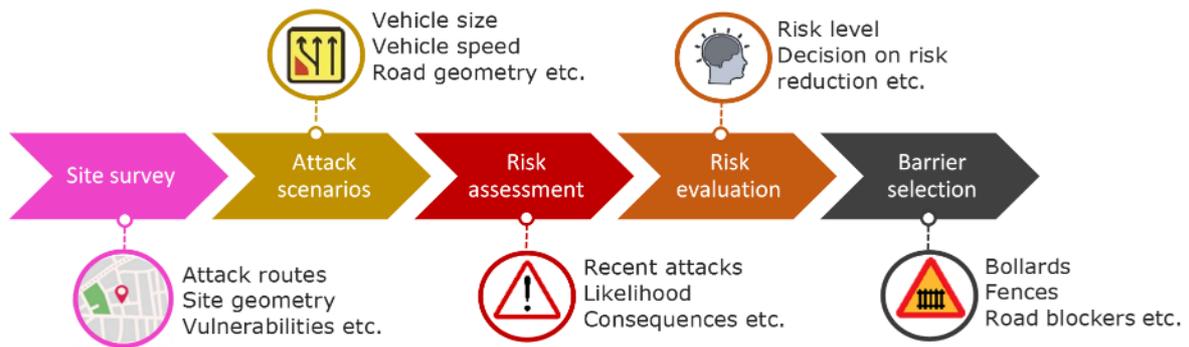
Figure 18: Risk assessment for the threat of vehicle ramming. Source: Karlos et al. (2018).

Speed-reduction measures can be used to significantly reduce the speed of vehicles and consequently the impact energy of a vehicle in the event of an attack. Examples of speed reduction measures (see also Figure 19) include:

- traffic islands;
- chicanes;
- bends;
- speed bumps (although less effective).
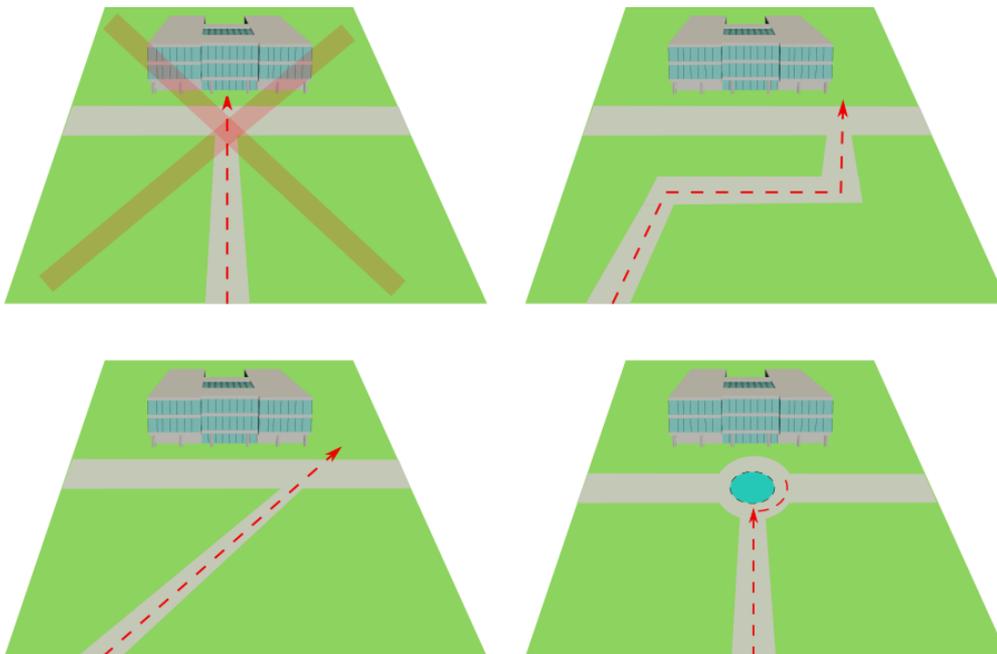
Figure 19: Different speed reduction methods: chicanes (to avoid direct attack approach routes) and indirect access to a site. Source: Inspired by CPNI (2014).

A detailed map of the surrounding area is required to identify all potential vehicle attack routes, and to ascertain approach angles, terrain type and road slope. Traffic lights and road signs can be ignored, as attackers will not obey the rules of the road. Threat vehicle attack lines and maximum vehicle speed at impact may be assessed through 2D or 3D assessments of the area's topography. All possible approach routes should be considered with the highest possible accuracy through computer-aided design drawings, photographs or satellite imagery. The assessment should consider gradients, road surface (e.g. asphalt, gravel and cobblestone), curves, road conditions, kerbs and the presence of any street furniture that may affect the speed of oncoming vehicles. The type of vehicle and its speed at impact are important factors in the selection of appropriate barriers, which will need to sustain the impact while absorbing the resulting kinetic energy. Minimising vehicle approach speed by implementing appropriate speed reduction measures allows the installation of lighter barriers that can be smaller and therefore less obtrusive.

The analysis of the topography of the surrounding area should not be limited to the road network and the potential approach routes, but should also include information on the usual climate conditions, the expected flow of traffic, the predominant architecture and adjacent parking facilities. All these data should be used to select the most appropriate type of VSBs, in terms of design and mode of operation, to fulfil the requirements of the public space to be protected.

Vehicle ramming tool: automatic site assessment

In order to select appropriate barriers, the maximum speed of a potential threat vehicle at the location of interest is calculated. The European Commission's Joint Research Centre (JRC) guideline (Karlos et al., 2018) presents an analytical approach to calculating the maximum speed using the vehicle's acceleration characteristics and the geometric features of the surrounding road network. The JRC has developed a vehicle ramming tool ([14]) that uses the street geometry from OpenStreetMap ([15]) data (Figure 20). After selecting the target area and the potential threat vehicle, the tool analyses all potential access routes to the target and estimates the vehicle's maximum speed depending on the street network (e.g. street length, curvature, inclination and width). It facilitates the identification of the most critical access points of an area in terms of vehicle access speed and the selection of the appropriate barriers based on the vehicle category and its maximum speed.
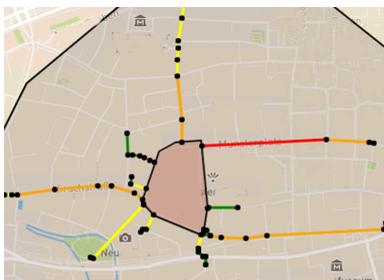
Figure 20: Vehicle ramming tool: result

([14])   Access can be requested through email (JRC-PUBLIC-SPACES@ec.europa.eu).
([15])   OpenStreetMap is a free map of the world that relies on the contribution of volunteers and is available online (Openstreetmap.org).

Case study: redevelopment project of the zone Las Ramblas, Barcelona, Spain

Objectives
The objectives of the redevelopment of the zone include:

- maximising the area that pedestrians can use;
- reducing motorised traffic in the zone (only authorised vehicles to have access);
- constructing three main crossing areas to improve the links between neighbourhoods, allowing motorised traffic and pedestrians to share the area;
- reducing the risk of vehicle ramming attacks while minimising the use of obtrusive solutions and promoting the use of low-visibility barriers.

Risk assessment in the current urbanisation context and future risk reduction
Traffic manoeuvrability can be studied with specialised software such as AutoTURN, which predicts vehicle paths by taking into account the geometry of the area and vehicle speed. The tool allows the user to change the speed on a possible approach path and precisely place street furniture elements and barriers to avoid the penetration of protected spaces, enabling them to determine the maximum impact speeds of different kinds of vehicles. This helps to identify the required resistance and aesthetic design of barriers, taking into consideration the kinetic energy generated by a vehicle impact.

A report from the Technical Security Commission classified the risk in different areas of the project into four possible levels (very high, high, medium and low). The Technical Security Commission also proposed two main typologies of vehicles, considering the surrounding road network area. Based on these data, the project managers proposed protective measures that also had to be evaluated and approved by the Local Security Board (a body comprising local representatives and various police organisations managing the city's security).

Security solutions
The following security measures were implemented:

- access only for authorised vehicles, controlled using a CCTV system and automatic number plate recognition;
- the detection of incidents with automatic incident detection by cameras in high-risk places;
- the protection of crowded spaces with street furniture (lighting / existing trees / benches / bollards) to isolate traffic from pedestrians and block vehicle access;
- protection with specially designed bollards only in places with a high risk of attack and retractable bollards for managing the access of municipal services into protected areas or closing Las Ramblas to traffic.

Stakeholder management
The main challenge for stakeholders was finding a compromise that would ensure the security of the area while still providing a welcoming public space for pedestrians, respecting the historical importance of Las Ramblas, ensuring mobility and connectivity between neighbourhoods and addressing the needs of the commercial sector. It was important to take into account the public's sensitivity to the attacks that took place in August 2017.

The main stakeholders that were involved were the Local Security Board and the Urban Projects Department, Mobility Department, Economic Promotion Department and Participation Department.

Vehicle security barrier types

VSBs are designed to prevent vehicles from driving into an area that requires protection. ISO/IWA 14-2:2013 (Section 10) recognises two categories of VSB:

- passive VSBs
- active VSBs.

Passive VSBs are systems that lack moving parts, whereas active VSBs can move in order to allow vehicle/pedestrian access. Barriers in both categories may be surface mounted or equipped with a foundation (deep or shallow), and they may be deployed as permanent or temporary solutions (Table 5). More details about available barrier types and calculating the maximum vehicle speed at a particular site can be found in a JRC guideline (Karlos et al., 2018).

Table 5: Categorisation and examples of VSBs

	Passive	Active
	Bollards (fixed)	**Bollards** (rising, hinged, rotating or sliding) Dragon's teeth
	City furniture / street furniture Planters Walls, retaining walls Balustrades Benches Lamp-posts Bus shelters Bicycle racks Waste bins Advertising columns Water wells, water fountains, drinking fountains Sculptures Cultural elements	**Gate systems** (rising, sliding, swinging or swing arm) **Road blockers** Wedge barriers **Restraint systems** Nets Straps Fibres
	Fences (fixed)	
	Wire rope systems	
	Elements of landscape Ditches Bunds, berms Small streams Lakes Fountains Trees Tiger traps	
	Other installations Vehicle guard rails Barge barriers Concrete blocks Water-filled barriers Bulk material baskets	

Permanent versus temporary solutions

Permanent barriers may remain functional for hundreds of years, as demonstrated by the fact that some remnants of **medieval barriers** are still in place (although active systems require regular maintenance). Temporary barriers, in contrast, are employed for particular events or as a stop-gap solution until permanent measures can be installed (see Figure 21). However, it has been observed that temporary barriers sometimes remain in place for a very long time, irrespective of the initial intentions. Clearly, this should be avoided, as temporary barriers are less effective, functional and aesthetically pleasing than permanent solutions.

Figure 21: Permanent (left) and temporary (right) barrier solutions

Penetration distance

Penetration distance is the maximum perpendicular distance between two predefined points, the first on the barrier and the second on the vehicle, as described in IWA 14-1. The penetration distance depends not only on the vehicle type, its mass and velocity, but also on the barrier type. Certain barriers may cause the vehicle to experience large deformations, resulting in extremely high deceleration and therefore major debris dispersal far into the protected zone; this is especially the case with cargo trucks. In the case of other barrier types (e.g. wire rope systems, guard rails and fences), impact forces are lower, and increase more slowly, and vehicle deceleration is also lower. As a result, vehicles penetrate further into the protected zone, but debris dispersal is reduced (Table 6). The allowed penetration depth depends on the characteristics of the public space and the distance of the protected asset from the hardened perimeter, so serious consideration is required in selecting an appropriate VSB.

Table 6: Potential consequences of barrier impact forces

Barrier impact forces	Vehicle penetration distance	Debris dispersion
Higher	Lower	Higher
Lower	Medium	Lower

Requirements for continued operation after impact

VSBs are not necessarily required to remain undamaged. They are designed to mitigate the effects of an attack and, if the force of the impact is sufficient, may be severely damaged. However, certain active barriers may require to remain operational after an impact, in order to allow access by the police, firefighters and other first response vehicles; otherwise, it is necessary to plan for alternative access routes in these circumstances. Impact incidents may also be accidents; these are relatively common in city centres and pedestrian zones where access is granted for certain vehicles (e.g. local transport, loading/unloading of goods and utility vehicles).

Barrier spacing and positioning

Barriers (fixed or surface mounted) come in a variety of types, differing in their dimensions, material and design. Bollards and other similar measures are useful where **pedestrian permeability** is required. Barriers have to be at least 750 mm high, to be readily visible to drivers, for safety reasons, but not more than 1 200, mm so as not to be obtrusive. Barrier spacing is defined as the gap between two adjacent barriers, and should not be greater than 1 200 mm, measured 600 mm above the ground. This maximum spacing guarantees that the majority of vehicles cannot enter the protected zone while still allowing access by members of the public, including those in wheelchairs or pushing prams. Steel bollards have cross-sections between 300 mm and 500 mm and occupy little space compared with other barrier types.

Owing to the often unique requirements of **urban security**, new, innovative barriers are constantly being developed that can, for example, have shallow foundations, blend into their surrounding environment and be multifunctional (Karlos et al., 2018). Therefore, the examples given in Table 7 provide only an overview of the available options.

Table 7: Barrier requirements and possible solutions

Requirement	Solution	Examples
Pedestrian permeability	Permeable barrier set-up	Bollards, planters, lamp-posts
Traffic access	Active barriers	Retractable bollards, swing gates, road blockers
Little space	Barriers with small cross-sections	Bollards, lamp-posts, fences, planters
Enough space	Elements of landscape	Berms, ditches, city streams, lakes, fountains
Debris dispersion minimisation	Lower barrier impact forces	Fences, rope barriers, nets, ring mesh
Show force	Deterrent barriers	Bollards, wedges, gates
Hide force	'Invisible' barriers	Urban furniture
Environmentally friendly solutions	Blue-green barriers	Fountains, lakes, city streams, trees, plants, elements of landscape

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Case study: installation of street furniture benches on the Rue de la Loi, facing the European Commission's Berlaymont building, Brussels, Belgium

The perimeter of the esplanade in front of the Commission's main Berlaymont building in Brussels is protected against vehicle ramming attacks by a combination of existing protective measures (walls, bollards, etc.; Figure 22). However, four staircases provide access from the Rue de la Loi and the Schuman roundabout towards the esplanade. These staircases were unprotected against vehicle ramming attacks, potentially exposing the European Commission's staff members and assets.

Consequently, the European Commission's Directorate-General for Human Resources and Security decided to install concrete benches covered with granite and anchored in the ground to mitigate the threat. The benches and their concrete foundations are designed to resist ramming vehicles with a specified mass and speed.

Following a security-by-design concept, the appearance of the multipurpose benches (which also function as seating) is in harmony with the urban characteristics of the area and the appearance of the Berlaymont building.

No planning permission was required, as the anchored benches are on the Commission's land. Nevertheless, at the request of Brussels' authorities, a minimum distance between each bench is required to guarantee good access for pedestrians and for visually impaired people.

Figure 22: Granite-covered benches protecting the Berlaymont esplanade staircases

Foundation requirements

The proper design of barriers' foundations is essential to ensure that they can resist impact by transferring the impact forces to the surrounding load-bearing soil. Usually, foundations are constructed from steel-reinforced concrete, cast in place. This material is optimal in terms of strength, durability, flexibility of shape, design and cost.

Deep foundations, as required in the case of retractable bollards, can reach a depth of up to 2 –3 m. In this case, existing underground infrastructure and groundwater can present a problem, and a may require the installation of a drainage system.

Shallow foundations are usually less than 50 cm deep but may spread over a wider area compared to deep foundations. Shallow foundations are usually made of steel-reinforced concrete or steel alone and are used if the underground infrastructure (power and telecommunication cables, gas pipelines, water pipes, drainage systems, underground facilities, metro systems, etc.) does not allow for deeper foundations.

Temporary barriers usually do not bear a foundation**,** and they generally resist the impact forces through their mass and ground friction.

Ground surfaces vary drastically with respect to their **material** (e.g. concrete, asphalt, cobblestone, paving slabs, soil and gravel) and **texture** (wet, dry, dirty, etc.). Therefore, determining the coefficient of friction between the surface and the barrier is challenging. This uncertainty is therefore considered in the design of temporary VSBs. Moreover, temporary barriers may behave well under the tested speed but **may be pushed away** easily by a vehicle at a lower speed. To address such issues, the German standard DIN SPEC 91414-1:2021 requires a displacement test.

To increase their stopping power, surface-mounted barriers may be anchored to the ground with properly dimensioned pins, bolts or (hooked) dowels.

Soil

The bearing capacity of the ground (soil) is assessed (EN1997-1), in order to successfully withstand the impact forces applied through the barrier's foundation.

Verified foundations

Barriers whose performance have been assessed and certified through impact tests are accompanied by foundation drawings, including dimensions, scaffolding, installation details, reinforcing details, steel grade, concrete grade and soil-bearing capacity.

Certification

The performance of VSBs is certified through vehicle impact tests, which assess the barrier's performance when impacted by a certain vehicle type (i.e. with a certain mass; see Table 8) and at different speeds. Depending on the testing standard that is used for the certification process, the testing parameters may be different (e.g. location of reference points for penetration rating and vehicle mass). It is particularly important to appreciate the differences between vehicle impact tests performed following the recommendations of American standards and those performed in accordance with European standards. Engine geometries are likely to be different, and US vehicles are typically larger and have higher mass centres than their European counterparts. As a result, vehicle–barrier interactions may be very different; therefore, it is advised that barriers are certified using the predominant vehicle types in the country of interest.

Table 8: Selection of vehicle types according to IWA 14-1:2013

Vehicle type	Weight (kg)	Class
	1 500	M1
	3 500	N1
	7 200	N2A
	30 000	N3F
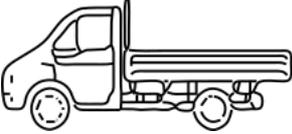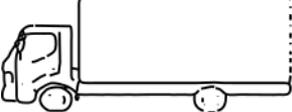
Attempts to standardise impact test specifications are currently under way. Most important are two new international documents to be published as ISO 22343-1 and ISO 22343-2. These standards will be revised versions of IWA 14-1 and IWA 14-2, respectively, and it is envisaged that they will replace the majority of the existing testing documents at international level.

Case study: city centre public realm improvements with impact-rated street furniture, Cardiff, Wales

In 2009, Cardiff city council began to plan a major development scheme to help boost shopping facilities and tourism in the city. This scheme was focused around the redevelopment and extension of the St David's shopping centre in the centre of the city, and the aim was to create an internationally renowned shopping, leisure, cultural and tourist destination.

In line with the United Kingdom's national strategy of encouraging urban planners and designers to consider incorporating counterterrorism features into vulnerable and high-profile crowded locations, the planning and design team at Cardiff City Council consulted with experts. This consultation focused on how security could be blended into public realm improvements under the guise of regeneration and renewal efforts to provide adequate protection against potential vehicle-borne terrorist attacks (capable of resisting the impact of a 7.5 tonne truck travelling at 50 miles per hour (80 km/h)).

The scheme installed 18 planters with a 50-litre capacity as part of the development, with further street furniture constructed between the planters in the form of bench seating. Further seats in the form of granite blocks were added and were considered attractive, minimalist and effective as a security measure (Figure 23).

Overall, the security design scheme provided an innovative solution to the counterterrorism requirements and in particular vehicle-as-a-weapon attacks. This integrated scheme utilised a range of street furniture products tested in accordance with British standards (British Standards Institution PAS 68, 2013) while remaining sympathetic to the historic architecture of the surrounding area.

Figure 23: Planters and granite block seats (left) and benches (right). Source: Jon Coaffee.

An example that typically describes the performance rating of tested barriers (in an abbreviated form) according to IWA 14-1 is shown in Table 9.

Table 9: IWA 14-1:2013 performance rating

IWA 14-1:2013 performance rating V/7200 [N2A]/64/90/3,0				
Vehicle impact	Vehicle mass (class)	Impact speed	Impact angle	Vehicle penetration distance
V	7.200 kg [N2A]	64 km/h	90°	3.0 m

Although the performance rating does not include dispersion of major debris, IWA 14-1 requires that the mass and coordinates of debris be measured and recorded in the test report as observations.

As already mentioned, until now the performance of barriers as protection against vehicles has been assessed and certified only through **physical impact testing**, which is described in the abovementioned standards. However, **computational methods** (numerical) offer new possibilities, as they have already been successfully employed for crash analyses and blast simulations.

Generic numerical vehicle models for simulations

Assessing the resistance of barriers or other types of protective systems to impact loads through numerical simulations requires the loading characteristics to be known. Force–time histories can be used only to a very limited extent, as the resulting force greatly depends on the type and design of the barrier.

The great number of elements in crash test vehicle models used in simulations provide too much detail to be used in this context and are generally not available from the manufacturers. Generic numerical vehicle models for the simulation of their impact against barriers are currently being developed by the JRC. The first model of N1 vehicle types is already available (Figure 24). More information about numerical impact simulations can be found in a JRC report (Valsamos et al., 2020).
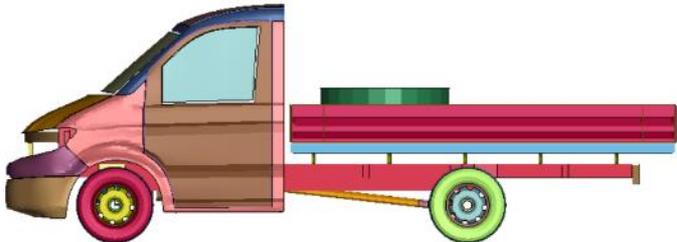
Figure 24: Example of a N1 vehicle simulation model

While physical tests are expensive (more than EUR 30 000 per test) and commonly limited to one specific impact scenario, numerical tests are cheaper and allow the testing of additional parameters (e.g. speed, impact angle and cargo) at minimum additional cost. Table 10 gives an overview of the pros and cons of physical and numerical testing. In the future, numerical techniques may considerably reduce the number of physical tests and contribute to the manufacturing of more effective and cost-efficient solutions.

Table 10: Comparison of physical and numerical testing – pros and cons

Testing/verification			
Physical		Numerical	
Pros	Cons	Pros	Cons

• Consideration of complicated interaction phenomena between vehicle parts • Real physical test	• Only one experimental set-up • Expensive • Few testing sites	• Cheaper • More experimental set-ups • Location independent	• Lack of debris rating • No common vehicle numerical models • Requires validation tests

Multifunctional vehicle barrier solutions

Barriers, such as bollards or concrete blocks, are **generally monofunctional**. They serve the one and only purpose of resisting vehicle impact. However, **further** needs with respect to **urbanity and the mitigation of climate change actions (heating up cities, flash floods and even biodiversity)** in cities (Figure 25) may be addressed through multipurpose measures that do not serve only security purposes.

Multifunctional barriers can be **street furniture** or **sculptures**, thus **enhancing urbanity**. Alternatively, they may take the form of plants or water systems to help **cool down cities**, **provide shade**, **promote evaporation**, **filter fine particles in the air**, and **provide a habitat** for insects, birds and animals (see Chapter 2).
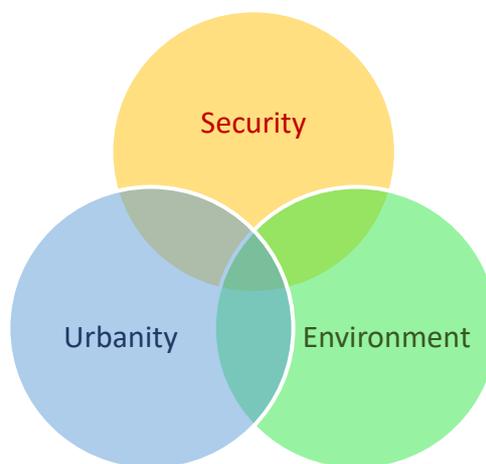
Figure 25: Requirements for multifunctional barriers

The European Commission's President, Ursula von der Leyen, launched the **New European Bauhaus** initiative in September 2020. It aims to establish a link between the **European Green Deal** and our **living spaces**. The New European Bauhaus is an emerging interdisciplinary creative movement. The European Green Deal is the centrepiece of the **European approach to sustainability**. It combines **climate**, **environmental** and **biodiversity** protection with **social justice and economic growth**. In addition, one of the Partnerships established by the Urban Agenda for the EU's focused its works on

the Priority Theme of "Security in public spaces" as part of potential set of actions contributing to improve the quality of life in urban areas. Therefore, we should combine the protection of public spaces with climate, environmental and biodiversity protection. This can be achieved by implementing blue-green barriers and barriers that are made of sustainable materials and that are operated using sustainable energy sources.

Using multifunctional barriers also creates a **cost-sharing** or a **cost–benefit balance**, as mentioned in Chapter 6. Thus, the costs can be evaluated with respect to the additional functions of barriers.

In addition, the USA's National Capital Urban Design and Security Plan, *Design and Testing of Perimeter Security Elements* (NCPC, 2002), states: 'The context of the surrounding streetscape should be considered when designing security measures. … [A] variety of attractive elements and landscape features can serve as anti-ram barriers. Such elements should foster a sense of openness …. Once these streetscape components are designed and tested, designers will be able to develop security schemes from an expanded palette of components. Having more options should help designers balance security needs with the desire to maintain beautiful and accessible streetscapes.'

Landscape features (e.g. ditches, bunds, berms, small streams, city creeks, lakes, terraces and tiger traps) can improve attractiveness, enhance urbanity and fulfil environmental needs. Bunds and berms can easily be erected if space is available.

The integration of security measures into the urban environment using multifunctional barriers should be based on the **security-by-design concept**, which is the basis for **creative design thinking** and **inspiration** leading to **innovation**. By following such a multidisciplinary approach, we generate **added value for security, urbanity and the environment**, and ultimately for society.

Aesthetically integrated solutions

The following two case studies present are of aesthetically pleasing solutions designed to replace existing installations mainly focused on security and 'target hardening'.

Case study: alternative, aesthetically integrated protective measures for the Breitscheidplatz, Berlin, Germany

On 19 December 2016, the Breitscheidplatz Christmas market in Berlin was the target of a terrorist attack. Fourteen people were killed and at least 67 people seriously injured in the incident, which involved a heavy truck. As a result, the Breitscheidplatz was secured with temporary barriers that have remained in place ever since.

The protective barriers have been the subject of much criticism from the general public and the media, who claim that they are **too martial, too obtrusive, too expensive and restrict freedom**.

This criticism was an opportunity to consider **alternative protective measures** that follow the principles of multifunctionality and hide force. Barriers can be used that are adapted to urban planning, that are multifunctional and that blend into the existing environment (Gebbeken, 2020), following the principles of the New European Bauhaus.

Prior to the design phase, the author carried out a feasibility study. This involved exploring the Breitscheidplatz and its neighbourhood in two steps. The first step consisted in collecting information by interviewing stakeholders and consulting online mapping platforms. The second step involved visiting the site and its surroundings to identify the existing elements of the public space that could serve as barriers.

The existing **avenues** of Budapester Straße and Tauentzienstraße may be extended at the Breitscheidplatz perimeter, so that trees could serve as a primary barrier element. Tree trunks are commonly protected with metal cage-type constructions and may be further reinforced to provide protection against hostile vehicle impact. In addition, hardened **lamp-posts** or **bus shelters** can be placed between trees. **Fixed bollards** can be constructed on **roadways** and **pedestrian crossings, although vehicle access will be allowed through two dedicated** locations. The construction of only a few **retractable bollards** is planned at these **access points**. **Reinforced bike racks** can also be installed to serve as additional barriers. Other barrier types, include **planters, benches, reinforced rubbish bins and architectural boulders**, provide variety and a **sculptural aspect** to the greater area of Berlin. Additional protection against debris dispersion and penetration can also be implemented (e.g. by using nets). The design has not yet been coordinated with the existing underground infrastructure because relevant data are still missing. The feasibility study shows that there are many ways to ensure protection against hostile vehicle ramming, in ways that are adapted to urban planning and the area's environmental needs.

Case study: redesign of the Commission's Charlemagne building, esplanade, European Quarter, Brussels, Belgium

The European Commission's Directorate-General for Human Resources and Security commissioned a security audit of the Commission's Charlemagne building. This identified the building's glass facades as being particularly vulnerable to a vehicle ramming attack, taking into account the current spacing of existing bollards.

The Directorate-General therefore decided to redesign the area to mitigate this risk. In the past, this private area was used exclusively by vehicles transporting VIPs.

In the redesign project, the esplanade was divided into two zones, a relaxation zone, consisting of benches and green areas, and a drop-off zone for VIPs, which also provides a new entrance to the building. The new equipment (benches and planters) conceals the pre-existing continuous line of bollards protecting the building's facade.

As the esplanade is situated above a car park, the available foundation depth is very shallow. The bollards are therefore similar to the ones used on bridges. Planters were also installed to provide some vegetation. The project's security-by-design focus was on creating a space for relaxation in a green setting in a neighbourhood lacking such characteristics, while respecting the heightened security requirements.

Cost components

To **predict realistic costs incurred during the design, installation and use of a barrier, several expenses are considered**, as will be further discussed in Chapter 6. These include, but are not limited to:

- risk analysis;
- site-specific threat analysis, including the specification of vehicle types and potential maximum speeds;
- project management and the participation of stakeholders;
- risk communication (information boxes, leaflets, etc.);
- planning approval;
- tendering and awarding;
- possible compensation for traders;
- design and planning;
- construction site set-up and the possible diversion of traffic etc.;
- barriers and foundations;
- construction works (excavation, soil enhancement, reinforced concrete foundation works, relocation of underground infrastructure, etc.);
- integration into other security systems;
- system hardware and software upgrades, including licensing;
- staff costs;
- recurrent training;
- maintenance and servicing;
- warranty period and exclusions;
- decommissioning, removal, disposal and reconstruction.

Based on the above list it is evident that the barrier itself represents only a fraction of the total cost of the security project.

Installation issues

Underground infrastructures, subsoil and groundwater

Civil engineers often point out that **there is a city beneath the city**, which is composed of the complex **underground infrastructure**. Just below the ground surface are:

- power and telecommunication cables;
- gas pipelines;
- water pipes;
- drainage systems;
- underground facilities;
- supply and disposal lines;
- sewers;
- shafts;
- water reservoirs;

- tunnels;
- metro systems;
- underground parking garages;
- ancient monuments.

If **near-surface underground infrastructures** are present, deep foundations cannot be constructed. If barriers cannot be positioned in an alternative location, then either shallow foundations are required or the underground **infrastructures are relocated**, often at great expense. Shallow foundations require a significantly larger surface area than deeper foundations, which is often not available. As a result, the cost of installing foundations can significantly exceed the cost of the barrier itself.

Exposure to weather and climate conditions

Barriers have to resist and operate under **various environmental conditions**, for example:

- high or low temperatures (heat expansion and cold contraction);
- rain and underground water (drainage and protecting electrical components);
- humidity and salty air in coastal regions (rust protection);
- fine particle dust.

Material characteristics

The most common materials used for barriers are steel, reinforced concrete and natural stone. The advantages and disadvantages of each material may be considered when designing site-specific security solutions.

Steel or stainless steel can be used in almost any design, and its tensile strength is roughly six times higher than that of concrete. Thus, steel allows the design of barriers with smaller cross-sections than concrete. However, steel barriers may require more maintenance than other materials. For example, routine painting is necessary to prevent rust, unless stainless steel is used.

Reinforced concrete (steel bar or fibre reinforced) barriers are less expensive and require little maintenance compared with steel barriers. Their colour and appearance allow them to be harmoniously integrated into city centres, although owing to their brittle nature they may produce fragments during explosive events.

Natural stone barriers are usually bigger than the previously mentioned solutions. Their impact performance is usually not certified and smaller ones may be easily fragmented during explosive events.

Combined or composite materials may be preferred for aesthetic reasons and are composed of a combination of the previously described materials.

Case study: encased, crash-rated bollards in granite spheres, Copenhagen, Denmark

Between 2015 and 2019 in Copenhagen, Denmark, the Christiansborg Palace, which houses the parliament, the Prime Minister and the Supreme Court, incorporated crash-rated bollards encased in Nordic granite spheres – carved from the same stone as the facade of the palace – in a 'string of pearls' formation into its public space's design to restrict hostile vehicle access. This landscaped design solution replaced roughly cut blocks of stone and large planters that had previously provided protection, creating what was referred to by the designers – GHB Landscape Architects – as 'peacekeeping architecture'.

Blast mitigation measures

As part of a holistic approach to protecting public spaces from terrorist attacks, **all relevant threats should be considered, as discussed in Chapter 3**. IEDs may be transported by vehicles (VBIEDs), people (PBIEDs) or even cargo bicycles or unmanned aerial systems.

Blast assessment

Protecting a structure against external explosions requires the calculation of the blast loads that have to be sustained by its structural and non-structural components. The most commonly used engineering approach is based on empirical and semi-empirical methods. More comprehensive mathematical tools, for example explicit finite element codes, can be employed to calculate more complicated phenomena, such as channelling and shadowing effects, at the expense of added complexity and computational time. Figure 26 presents an overview of the steps taken to decide on appropriate hardening measures against IED attacks.

```
Risk        •Asset definition(building type, open area, people etc.)
analysis    •Vulnerabilities identification (absence of security measures etc.)
            •Likelihood/consequences assessment (accessibility, importance, attendance etc.)
            •Risk evaluation (attack scenario prioritization, acceptable/untolerable risk etc.)

Stand-off   •Existing perimeter protective measures (fences, detection systems etc.)
distance [R] •Site geometry (inclination, natural or artificial barriers etc.)
            •Deterrence measures (surveillance systems, security guards etc.)

Charge      •Possible transportation means (bags, cars, trucks etc.)
weight [W]  •Accessibility to explosive materials (regional safety characteristics, past events etc.)
            •Charge types (TNT, ANFO, TATP etc.)

Blast       •Calculation of scaled distance [Z]
analysis    •Determination of blast parameters (peak overpressure, positive impulse etc.)

Mitigation  •Structural hardening (structural member reinforcement, laminated glass employment etc.)
solution    •Physical/digital hardening (reinfoced police presence, surveillance, alarms etc.)
```

Figure 26: Steps to be followed to decide on appropriate hardening measures against IED attacks. Source: Karlos and Larcher, 2020).

There are several ways to assess the effects of a blast on a structure, including through individual blast parameters, diagrams or numerical simulation tools.

Peak pressure and impulse parameters

The peak pressure and the impulse of a charge at a certain distance can be calculated using several formulas, such as the Kingery (Kingery and Bulmash, 1984) formulas, assuming spherical or hemispherical conditions. Multireflections, channelling or shadowing cannot be considered. Tools such as the UNSaf*er*Guard ([16]) facilitate the calculations. More information on the procedure that can be followed to calculate the loads to be applied to a structure as a consequence of a blast can be found in the relevant documentation (Karlos and Solomos, 2013).

Pressure–impulse diagrams

Peak pressure–impulse diagrams summarise the results of many experiments or simulations in one diagram in the form of iso-damage curves. They also allow the behaviour of structures under different loading conditions to be assessed. The JRC has developed the BlAssTool ([17]) (Figure 27), which contains several iso-damage curves derived from the literature facilitating the pre-assessment of the performance of a blast-loaded structure.
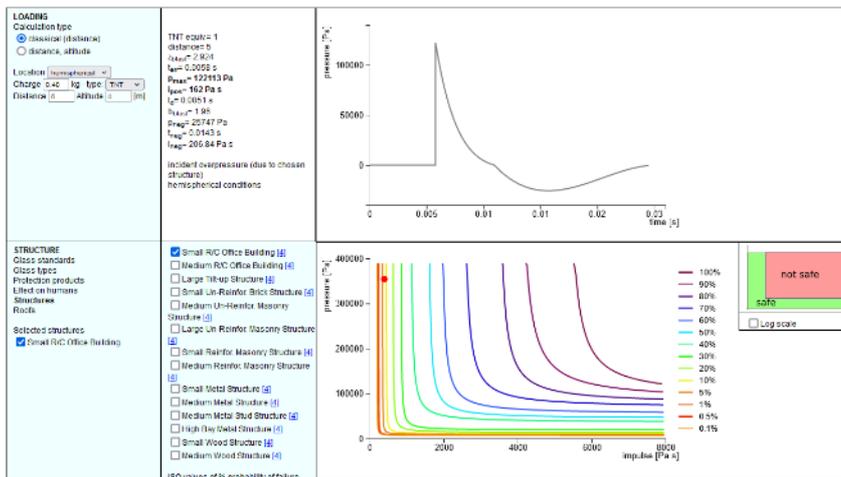
Figure 27: Example from the BlAssTool for the calculation of peak pressure / impulse parameters and comparison with pressure–impulse iso-damage curves

Numerical blast simulations

In the case of multireflections, shadowing and channelling phenomena, numerical simulations can support the assessment of a structure's performance under blast loads. One example is the explicit finite element software Europlexus ([18]) (Figure 28), which was co-developed by the JRC and the French Alternative Energies and Atomic Energy Commission.
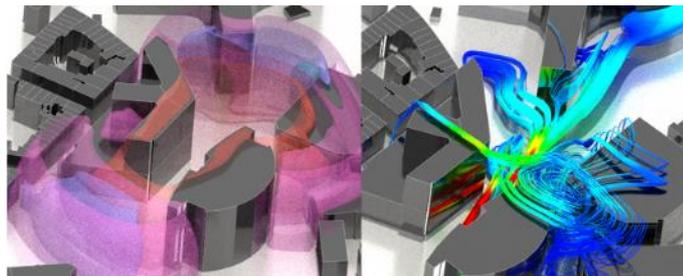
Figure 28: *Example from a blast simulation using Europlexus – pressure wave and air flow in an urban environment*

Physical testing / certified products

For a given threat (charge–distance combination), experiments can be performed using either free-field or shock tube techniques. The relevant standards are presented in the References.

Explosion hazards

The most significant hazards for people and buildings resulting from attacks with explosives against public spaces (Figure 29) are:

- blast waves;
- primary fragments (e.g. nails and casing parts);

([18])   http://www-epx.cea.fr/

- secondary fragments (e.g. flying or falling debris, window glass splinters and detached urban furniture).

Even though primary and small secondary fragments, accelerated by the explosion, may travel up to hundreds of metres, the peak pressure of a blast wave decreases rapidly with the stand-off distance. Securely ground-anchored street furniture, such as rubbish bins, bus shelters and chairs limit the probability of flying objects after an explosive event.
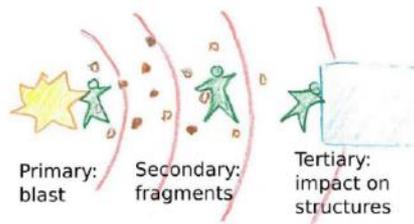
Figure 29: Hazards emanating from an explosion

Distance as a protective measure

The **stand-off distance** is the primary parameter protecting people and buildings from the effects of a blast wave (Figure 30). Every **additional metre of distance significantly reduces the blast wave's intensity**. Security barriers serve to increase the distance between a VBIED and the area or the building that has to be protected. The cost of building **hardening** can be significantly higher than the cost of increasing the stand-off distance through the installation of perimeter barriers, if this is feasible.
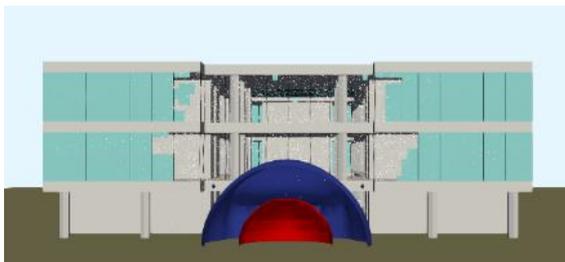
Distance: 25 m. Blue: zone of ear drum rupture; red: zone of 50 % fatality; damaged glass more localised because of short distance of blast from the building.

Distance: 55 m.

Distance: 65 m.
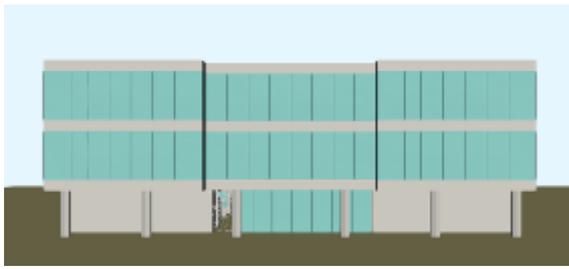
Distance: 70 m.

Figure 30: Blast effects, including breakage of glass and effects on humans

Building protective measures

In addition to enhancing **protection by increasing the stand-off distance, reinforcing the following aspects could reduce the effects of an explosion in a public space:**

- the building's envelope (windows, doors and facade);
- the load-carrying structure;
- security (through technical installations).

The **shape of a building** influences how the blast pressure is distributed across the building's envelope. For instance, blast pressure is less amplified by buildings of a convex shape. The weakest parts of the building envelope are usually the windows, doors or facade. **The required strength of protective measures** depends on distance from a possible blast; in practice, this means that protective measures demand to be greatest at ground level and can be reduced at higher levels.

Specialised **safety films**, **safety glass** systems (e.g. laminated safety glass) and **safety facades** (rigid or flexible) have been developed so that the glass fragments created during explosions remain attached to the safety film or to the embedded foil between glass layers. Blast-resistant windows and doors offering different levels of security, and complying with various standards (EN 13541, EN 13123-1, EN 13123-2, ISO 16933 and ISO 16934), are commercially available. These can also be combined with protection against forced entry or ballistic attacks. The load-bearing structure should be designed such that, in the event of relatively large explosions occurring close by, the failure of one or several structural elements **does not cause the (progressive) collapse** of the entire building or a part of it (NIST, 2007) (Table 11).

Table 11: Counterterrorism design principles and measures

Counterterrorism design principles	Example of measures
Better hostile vehicle mitigation measures and better traffic management	- Structural measures that prevent unscreened vehicles from accessing the building or site - Measures that reduce the speed of approaching vehicles, such as tight bends or chicanes
Better blast resistance	- A strengthened perimeter to prevent a penetrative (ramming) attack and reduce the proximity of parked vehicles - Use of building materials that reduce the risk of

	fragmentation (e.g. blast-resistant glazing) and a structural design that reduces the risk of building collapse

Source: After HomeOffice (2012).

Entrance areas

The design of entrance areas to sites or buildings, such as guardhouses, gatehouses or dedicated detection zones, may require hardening to prevent an active shooter from entering the protected site or building. These areas, of sufficient strength to protect against external explosions, allow the release of a potential pressure wave if there is an internal explosion. As a result, specific pressure release surfaces may be incorporated into the design along with specialised meandering blast walls to stop the blast wave from entering the main building (Figure 31).
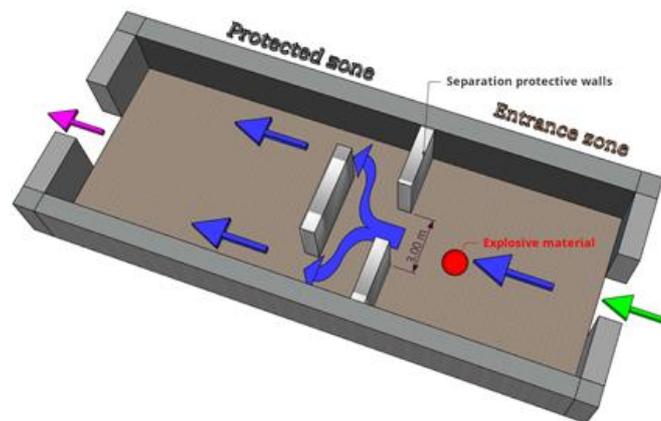
Figure 31: Example of a meandering wall. Source: Karlos and Larcher (2020).

Case study: visitor welcome centre in the Commission's Berlaymont building, Brussels, Belgium

To ensure enhanced protection for visitors, VIPs, staff and Commission buildings, the Commission adopted a global action plan in 2015. One of the measures of this plan was the construction of a welcome centre (WCT), attached to the main Berlaymont building of the European Commission in Brussels. This building houses approximately 3 000 staff members, including the commissioners.

The project's main objective was to improve the current risk mitigation strategies against firearms or explosive attacks carried out by individuals or groups of people.

In accordance with the initial design, all security checks take place inside the WCT, allowing for a clear separation between staff and visitors and ensuring that only previously controlled visitors can access the premises, including visitors with reduced mobility. The WCT project also includes implementing a specific VIP entrance, a vehicle drop-off zone and designated VIP vehicle parking.

Main security installations/measures:

- strengthened identity checks before admission to the WCT and consequently to the Berlaymont building;
- separate pedestrian flows (staff/visitors);
- increased number of X-ray checkpoints and improved screening efficiency;

- increased proximity of armed intervention teams in the event of an attack;
- enhanced anti-intrusion measures and blast resistance of the WCT;
- the WCT's ability to deploy a series of physical protective measures if there is an attack to prevent access to the main Berlaymont building;
- improved security of the VIP esplanade and VIP access into the building.

In the case of certain critical infrastructures, protective measures should be plainly visible. However, this is not always desirable and, therefore, the concept of **'invisible' barriers**, that is, barriers that are not immediately recognised by citizens as protective measures, was developed. Invisible barriers can take the form of objects that are already present in the public space. Alternatively, new barriers that also address social demands (e.g. bike racks or benches) may be installed.

Mitigation of explosion effects through innovative measures

The **protective effect of plants** during explosions has been experimentally tested and the results showed that they can **reduce the pressure of an explosion wave by up to 60 %**.

Moreover, **water fountains made of ring mesh running with water reduce the pressure of explosion waves by up to 50 %**. These also **provide protection against vehicle impact and flying objects** (Xiao et al., 2020).

These examples show that there are **no limits to creativity** in the development of environmentally sustainable barrier systems.

Case study: protection against vehicle attacks and VBIEDs in Feldherrnhalle/Odeonsplatz, Munich, Germany

As part of the concept study Urban Security of Munich (UrbaSiM), it was investigated how the square in front of the Feldherrnhalle in Munich (part of the Odeonsplatz) could be best protected against vehicle attacks and VBIEDs. During the **first examination of the square**, no elements were found that could serve as barriers to limit vehicle access and increase the stand-off distance from the surrounding buildings and the square. In the immediate vicinity, however, there are sculptural bollards made of granite, whose design could be adapted to create barriers.

Figure 32: Historical city streams in 12 Westlicher Stadtgrabenbach, Munich. Source: Section of image from Wikimedia Commons, Background: OpenStreetMap; User: Chumwa, Streams; User: Vuxi, CC BY-SA 2.0 licence).

During discussions with representatives of the city of Munich on the concept study, a map of the historic city streams in Munich (Figure 32) was provided. The map shows that the western

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underground stream Stadtgrabenbach is located in the exact spot where temporary planters are currently serving as barriers (Figure 32, labelled 12).

These considerations gave rise to the concept study. After elevation, the city stream flows in an above-ground trough, which will serve as a barrier against attacks with vehicles. To the left of the elevated city stream, only two **active barriers** are required for **vehicle access**, allowing passage widths of 2.75 m to 4.75 m. It was decided that the rest of the barriers would be designed in the form of the existing sculptural bollards. During events, for additional protection against potential debris from vehicle ramming attacks or blast explosion fragments, a retractable fence can be added, mounted inside the trough wall.

EC-funded research on security of public spaces

EC research Framework Programmes

The development of new technologies and innovative approaches to increase security in public places was financed through the EC research Framework Programme Horizon 2020, e.g. a specific call allocated funds to consortiums that develop solutions to protect the "soft targets" (public spaces such as malls, open crowded gathering areas and events and non-restricted areas of transport infrastructures) from "low cost" attacks. PREVISION ("Prediction and Visual Intelligence for Security Information"), AIDA ("Artificial Intelligence and advanced Data Analytics for Law Enforcement Agencies") and APPRAISE ("fAcilitating Public & Private secuRity operAtors to mitigate terrorIsm Scenarios against soft targEts") resulted from this call and have been providing very useful results. As an example, PREVISION has developed scalable and customizable tools that enable big data streams analytics used by several Police Authorities, which find that the combination of psychological, sociological and linguistic models, in conjunction with historical data patterns, all of this based on algorithmic analysis able to operate in a very short time, is a clear and strong added value in predicting and countering suspicious actions in public spaces.

Furthermore, the call "Security for smart and safe cities, including for public spaces" funded IMPETUS (Intelligent Management of Processes, Ethics and Technology for Urban Safety), increasing city resilience to security events in public areas by covering the entire physical and cybersecurity value chain, and S4AllCities (Smart Spaces Safety and Security for All Cities), which instead promotes intelligence and information sharing amongst security stakeholders to make cities' infrastructures, services, ICT systems and Internet of Things more resilient to attacks in public spaces.

Other projects, funded by the 2018-2020 programme of Horizon 2020, have contributed to improving the resilience of European cities to attacks on public spaces, even if they do not have these as their main focus: STARLIGHT, aimed at increasing the expertise and capacity of law enforcement authorities against AI-supported crime and terrorism, ODYSSEUS, that is developing tools to improve prevention, countering and investigation of terrorist incidents affecting also public places, and INHERIT, that is developing solutions to counter attacks by means of explosive precursor chemicals.

Under the current Horizon Europe framework programme, relevant projects are funded in calls under the area 'Better protect the EU and its citizens against Crime and Terrorism'. They aim to improve security of public spaces and public safety, while at the same time preserving the open

nature of urban public spaces, with particular focus on detecting firearms and other weapons, as well as CBRN-E materials. As early as 2022, some relevant projects are funded, such as SAFE-CITIES ("riSk-based Approach For the protEction of public spaces in European CITIES") that aims to support excellence in the protection of public spaces, by delivering and demonstrating a security and vulnerability assessment framework.

Internal Security Fund

In line with the EU Action Plan to support the protection of public spaces, the European Commission has also funded a total of 35 actions from 2017 to 2020 via the PROTECT calls, under the Internal Security Fund (ISF). The actions selected cover a wide range of topics, such as the protection of places of worship, CBRN-E (Chemical, biological, radiological and nuclear substances and explosives) threats, critical infrastructure protection, or strengthening the detection of threats by detection dogs in public areas.

Project **EUProtect** was awarded under the 2018 call, and its goal is to develop new concepts of urban landscape design aiming at reducing the vulnerability of public spaces against terrorist attacks while taking into consideration the changing nature of this kind of threats. **PACTESUR**, from the 2017 call, seeks to shape new European local policies to secure public spaces against terrorist attacks through a bottom-up approach that brings together local decision-makers, security forces, urban security experts, urban planners, IT developers, trainers, front-line practitioners and designers.

Among the ongoing actions addressing the vulnerabilities of "soft targets" like sports facilities and shopping centres, we may find projects like **Mall-CBRN** (2018) and **Safe Stadium** (2020). The former tackles the emerging threat of food terrorism by creating a food defence programme as well as a comprehensive prevention and response to CBRN-E threats programme, while the latter aims to develop an integrated CBRN protection system for sport facilities in accordance with the Good Practices to support the protection of public spaces.

In the area of protection of places of worship, projects like **ProSPeReS** (2020) aim to develop a set of preventive measures against terrorist threats comprising tools, procedures, equipment, improvements in infrastructure according to the concept of security-by-design and cooperation protocols with public services. On the other hand, **SASCE** (2020) conducts large scale pilots using technology-enhanced security solutions to increase the level of preparedness of faith communities against potential terrorist attacks.

The new PROTECT call launched in 2022 will finance a new generation of initiatives that are expected to build upon the results achieved so far by the abovementioned projects.

Further EC funded research will develop innovative solutions, knowledge and methods for security in public spaces[19].

Key take-aways

There is no one-size-fits-all solution

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[19] https://home-affairs.ec.europa.eu/policies/internal-security/innovation-and-security-research_en

Public spaces vary greatly according to their location, use and principal function. Accordingly, selected protective security solutions should be adapted to the individual contexts. A large variety of protective solutions are available; however, they vary greatly with regard to cost, functionality, installation requirements, protective capability and social acceptability. Expert advice on adapted solutions may be helpful in narrowing down the available choices, but may also focus on integrating site-specific solutions.

Beware of the overall costs

The prediction of realistic overall project costs can be challenging, and the actual physical protective measures may only account for only a fraction of the overall cost. Additional costs, such as the costs of threat and risk analyses, engineering expertise, project management, foundation and construction works, the relocation of underground infrastructure and life cycle costs, should be carefully considered.

Expert knowledge

The implementation of protective measures involves a number of technical aspects that require specialist knowledge from various disciplines. In particular, threat and risk analyses, hostile vehicle mitigation and blast assessments are crucial for well-calibrated design decisions and the selection of appropriate protective solutions.

5 Public space project management in line with the security-by-design concept

Public space projects focused on integrating security measures can be very complex, not only because of their scope and budget but also because they involve a plethora of stakeholders. When applying the security-by-design concept, which renders security aspects an integral part of project planning, it is important to adhere to well-tested project management techniques, tools and methods. Stakeholder management and communication play a crucial role in these project management processes.

As the saying goes, project management costs time and money, but no project management costs more time and more money. Project management is about the efficient and targeted use of available resources.

Scope and main causes of project failure

The scope of project management depends on the project's size and complexity. The scope outlines all aspects of a project, including related activities, resources, timelines and deliverables, but also the project's boundaries (what is included and what is not included). A project's scope also includes key stakeholders, processes, assumptions and constraints.

In the protection of public spaces, projects' scopes are closely linked to the risk level (the product of the probability of occurrence and the extent of possible damage) for a given threat scenario. Chapter 3 elaborates on the topic of risk assessment techniques. **Risk analysis is the first main task in project management when designing public spaces to enhance security.** The goals of protection are defined based of this analysis and defined risk criteria or the acceptable risk, as further detailed in Chapter 6. The risk analysis at the beginning of the project is fundamental, because all further measures are based on its outcome.

The three most common causes of project failure are all rooted in insufficient threat and risk analyses:

- unrealistic or overambitious project planning (e.g. not feasible or budget not fitting to design goals),
- decisions that are not made or are made too late (e.g. definition of the acceptable risk and clearly defined risk criteria),
- unclear or frequently changing objectives (resulting in iterations of the planning process).

Following the risk analysis, the scope of project management is defined by answering questions such as the following.

- What is the available budget for security-by-design protective measures?
- What political interests should be considered?
- Should individual public spaces or entire urban areas be considered?
- Are permanent or temporary protective measures or a combination of both intended?

- Is the direct implementation of the measures planned or should a feasibility study be carried out first?
- Is it possible to establish changes in the surroundings of the protected area, for example in order to reduce the velocity of approaching vehicles, enlarge the acceptable penetration distance or increase the stand-off distance?
- Will the protective measures only be retrofitted or is it possible to entirely redesign squares or areas?

A **steering committee** for public space projects is usually formed or determined by the commissioning mayor or city council and is responsible for establishing the scope of project management and deciding on the budget and personnel available for the project. Project management is led by **a small and clearly defined group of a maximum of three people that acts as the point of contact** and bears the main responsibility for managing the project. This group should be provided with appropriate powers and competencies by the steering committee (including budget and personnel management and the authority to delegate tasks and to communicate with stakeholders).

Project management methods and processes in line with the security-by-design concept

Once the budget, the personnel and the scope of project management are defined, actual project control (the execution of the project management plan) begins. For this purpose, various classic and agile methods (Schwaber, 2004; Jovanovic and Beric, 2018; Karlesky and Vander Voord, 2008; Cervone, 2011; Lechler et al., 2012) or Kanban (Brechner, 2015) are available.

Classic and agile methods are not mutually exclusive (Gablas et al., 2018) and can be combined and used equally in a project. Classic methods are helpful for structuring the whole project without going into too much detail, while they usually span over longer periods. Agile methods can be particularly useful when scenarios are to be investigated and then compared with each other and have a shorter planning horizon.

Case study: Rembrandt Square pilot project – agile project management for safe and sound urban nightlife, Amsterdam, the Netherlands

In 2015, the city of Amsterdam, along with the local police, implemented a pilot project, 'safe and sound urban nightlife'. The focus was on changing mentality, social norms and public behaviour, and on encouraging club owners and the relevant authorities to be socially responsible and to work to enforce these norms, rather than on combating the effects of excess alcohol or drug consumption. The pilot was built on a new 'learning by doing' / partnership approach and shows **how classical and agile methods can be combined in a security-by-design project**.

The strategy was based on three key approaches.

- **A partnership approach.** The partners (residents, the mayor's office, bars / clubs / business owners, city management, the local police and the public prosecutor) have a common interest and all partners contribute as far as they can.

- **A clean, sound and safe approach.** Aligned with the partnership approach, the nightlife area is considered a single venue, and adopts an integrative perspective that combines physical and social/organisational measures and focuses on both nuisance and security risks (e.g. terrorism).

> - **An innovative and learning-by-doing approach.** Innovative and traditional measures are combined. As this was a pilot project, it was possible to implement temporary measures and monitor their effects, allowing hands-on quick evaluation research followed by immediate changes in policies and approaches (agile). Measures were implemented in their definitive form only when proved to be effective.
>
> The learning-by-doing approach also meant that antiterrorism measures could be implemented quickly while still being aesthetically pleasing.

Widely used project management standards include:

- ISO 21500, providing guidance on project management;
- Individual Competence Baseline Version 4.0, published by the International Project Management Association (IPMA, 2015);
- A Guide to the Project Management Body of Knowledge (the PMBOK® Guide), published by the Project Management Institute;
- PM2 methodology ([20]), as developed by the European Commission based on the PRINCE2® project management system created by Axelos Ltd (2017).

The assignment of project management processes to process groups and knowledge areas in this chapter is based on the *PMBOK® Guide*. Other standards use different classifications. Nevertheless, the basic structure is similar to the classic approaches.

There are a large number of project management tasks. The processes to be considered can be divided into five groups:

- initiating processes
- planning processes
- executing processes
- monitoring and controlling processes
- closing processes.

In this chapter, we focus only on project management processes that are particularly important for the security-by-design concept. Security concerns are established as an undisputed framework condition and all further efforts in the project should be aligned with them. As security-by-design projects involve a wide variety of stakeholders, it is of central importance to manage the expectations of, and to take into account the interests, demands and concerns of, all stakeholders, and to make good use of their influence, expertise and experiences. Stakeholder and communications management are of paramount importance for a project's success.

Initiation: the cornerstone for the success of a project

The course of the entire project is set during the initiation phase. The first step is to formulate the **project charter**, which defines the project's objectives. Based on the set objectives, the requirements, the content and the scope of the project can be defined. These become part of the work plan. From this, work packages and milestones are derived, which influence budget, schedule

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and time management and form the basis for risk management. Here, the risk analysis is not about the threat to public spaces but concerns the risk to the project's success.

Identifying the stakeholders is the second step of the initiation phase before starting the planning phase. The early identification of stakeholders is crucial, and forms the basis for stakeholder and communications management. It is not enough to just list the stakeholders; it is also important to analyse and to document:

- different stakeholders' interests;
- the nature and extent of stakeholders' participation in the project;
- relationships between the different stakeholders;
- stakeholders' dependencies and interdependencies;
- stakeholders' influence on others and on the execution of the project;
- stakeholders' impact on the success of the project.

The processes of stakeholder identification and analysis should not be carried out only in the initiation phase; but repeated periodically during the project.

In projects embracing the security-by-design approach, listing the stakeholders is a task that should not be underestimated. Potential stakeholders can be:

- the main stakeholders (e.g. the city council / mayor or the private asset owner);
- district administration departments, district committees or district inspectors;
- police departments, fire departments or rescue and emergency services;
- event and assembly offices;
- legal departments;
- municipal field services;
- mobility departments issuing temporary and permanent traffic orders;
- civil engineering units (involved in road planning, maintenance, operation, traffic control technology);
- construction site coordinators;
- offices for the preservation of historical monuments;
- urban development planning and urban design commissions;
- urban space management and horticulture departments;
- tendering and contracting offices;
- city treasuries (involved in finances);
- departments of labour and economy (involved in events);
- ministries of the interior;
- utilities and waste management services (water, electricity, gas, telecommunications, waste, etc.);
- public transport companies;
- suppliers/manufacturers of protection systems;
- planning offices (architects or civil engineers);
- construction companies or suppliers;
- external consultants (scientific/technical);
- delivery services / logistics companies;
- tradespeople or traders;
- residents or representatives;

- event organisers/promoters;
- taxi companies;
- the hospitality industry, the catering industry and clubs (including car and bicycle clubs);
- disability advisory boards / representatives;
- the media.

To capture the full range of potential stakeholders and keep the list up to date, it is helpful to look at comparable projects, to consult experts and to conduct market analyses, research, surveys or brainstorming sessions.

Next, the stakeholders can be clustered according to their interests and influence, for example in the form of a stakeholder analysis matrix.

Based on the stakeholder analysis, a **stakeholder management strategy** is developed. This strategy is usually accessible only to the project management team and is often presented in the form of a stakeholder analysis matrix. It records the interests of the stakeholders, their potential impacts and possible strategies for further engagement.

Communication management: managing expectations and keeping track

The key to effective communication is not only to communicate proactively and distribute precise information to the right recipients at the right time but also to tailor the message. A **communication management plan** outlines the structure and tasks of communication during the project. It lists the necessary processes for the timely and appropriate generation, collection, distribution, storage, provision and use of project-related information.

When creating the communication management plan, the following questions should be answered.

- What information to communicate (invitations, minutes of meetings, project status reports, information for the public/media, results from working groups, blueprints/drafts, schemes/plans, etc.)?
- Why does the communication have to take place (gathering or providing information, encouraging or ensuring participation, making or communicating decisions, tendering, commissioning tasks, etc.)?
- Between which participants or to whom does the communication take place (internal or external stakeholders, steering committee, landscape architects or other planners, the fire/police department, subject matter experts, etc.)?
- Which means of communication are used?
- Who is responsible for sending and providing the information?
- When or how often does the communication take place (on a regular/recurring basis or occasionally / by appointment)?
- What data management systems are used (push/pull, cloud-based, etc.)?
- Are encryption methods required?
- How will communication be documented?
- Professional/external support (from the public relations department or agencies, communications training, IT support, etc.)?

Link with risk and cost management

Avoiding risks from the very beginning is an important goal of project management. Clever communication and suitable formats for exchanging ideas create innovative security-by-design solutions. As protection against vehicle attacks often involves restricted access (at least temporarily) to, reduced speeds in and/or the installation of barriers (of all types, including bollards, street furniture, topography elements, walls/fences, etc.) in the area, the necessity for such measures but also their unintended side effects demand understanding and consideration. They limit the scope of action not only of attackers but also of regular users of public spaces. Important aspects of which a common understanding throughout the project team is required are, for example:

- a basic understanding of the underlying physics of attacks with explosives or vehicles (the importance of stand-off distance, the effect of blast waves on humans and structures, the influence of vehicle mass and speed, the behaviour of vehicles and barriers under crash conditions, etc.);
- the requirements of the police, fire department or other emergency services (access possibilities, width of access roads, towing radii, etc.);
- the requirements of utility and waste disposal companies (waste disposal, water, gas, electricity and communication networks, etc.);
- underground structures and supply and disposal networks (the restriction of foundations of barriers, access for maintenance and repairs, etc.);
- urban design and monument protection requirements (aesthetics, sight lines, traffic management, pedestrian flow, accessibility, historical background, etc.);
- the demands of service operation (usability, compatibility and integration into existing infrastructures, durability, maintenance, corrosion protection, etc.);
- the legitimate interests of tradespeople and residents;
- accessibility for people with disabilities;
- traffic planning and management;
- legal requirements or financial constraints.

Another important pillar of risk management is gathering information about lessons learned from previous/other projects. The provision of information is not limited to one's own project, but also includes sharing accumulated experience with a larger network.

The budget is another variable often unknown at the beginning of a project involving the protection of public spaces. The costs of protective measures are difficult to estimate in advance because of the various imponderables. A feasibility study can help in determining the financial outlay of the project. Projects are usually conducted using public funds. Political priorities may shift, and securing public spaces may be pushed to the side to make room for other objectives. More information about cost-benefit analysis of public space projects can be found in Chapter 6.

Key take-aways

Spend time on proper threat and risk analysis

Insufficient threat and risk analysis are often the root causes of project failure due to unrealistic or overambitious project planning, unclear or changing objectives, or deficiencies in decision-making

caused by initially ill-defined risk criteria. Spending time on these aspects is crucial for the projects' success.

Importance of good stakeholder and communications management

When following the security-by-design concept, security aspects become an integral part of project planning. However, public space design projects span over long periods and involve a high number of stakeholders with different and sometimes contradictory viewpoints, and boundaries and dependencies not fully known in the beginning. Therefore, good stakeholder and communications management are crucial for a project's success!

6 Risk treatment and cost-effectiveness of protective measures for public spaces

It is tempting to view security as an infinite good, something so important that no cost is too high. However, security budgets are not infinite and call for choices. Decisions regarding public security are improved if decision-makers consider the risks, costs and benefits of policy options. This has for decades been routine practice in policymaking throughout the world when establishing safety regulations in industries characterised by events or hazards that occur with low probability but have severe consequences, for example the engineering, insurance and pharmaceutical industries and many others.

The protection of public spaces depends on the threat environment, vulnerabilities, exposure and consequences. As shown in Chapter 4, a number of possible risk mitigation strategies are available, including bollards and access control, policing, blast-resistant strengthening, and so on.

Risk mitigation measures should be prioritised to maximise public security at a reasonable cost proportionate to the risk.

Balancing costs against benefits

The International Organization for Standardization's standard for risk management (ISO, 2018) notes that 'Selecting the most appropriate risk treatment option(s) involves balancing the potential benefits derived in relation to the achievement of the objective against costs, effort or disadvantages of implementation.' Hence, a conventional approach to cost-effectiveness compares the costs of security measures with their benefits, in terms of lives saved and damages averted. A security measure is cost-effective when the benefit of the measure outweighs the costs of implementing it. Therefore, a cost–benefit analysis (CBA) can help to inform the choice of risk mitigation methods. A CBA can reveal wasteful expenditures and allow limited funds to be directed to the areas where the most benefit can be attained.

The overall risk-based approach in terms of comparing the costs and benefits of security measures is shown in Figure 33.
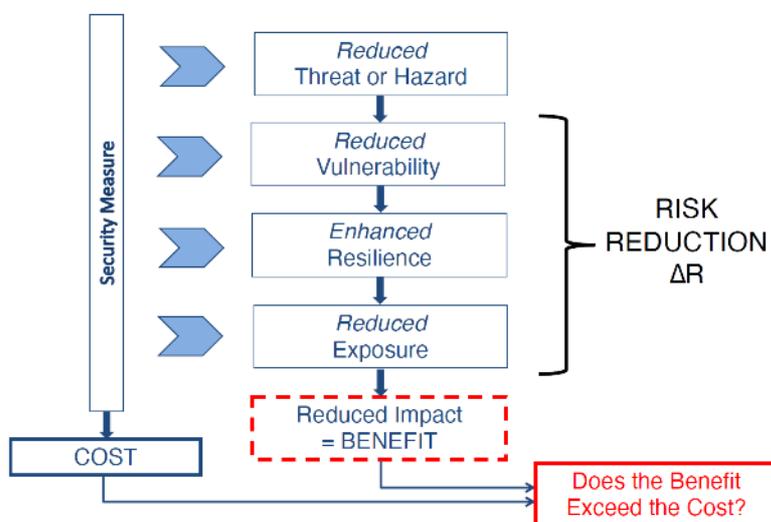
A CBA should to be tailored to the needs of the asset owner, regulator and other decision-makers. Many tools and methods are available for conducting a CBA. This chapter describes a CBA that may be used for preliminary analyses of a specific site / event or risk screening of a large portfolio of sites or assets. It provides a first pass at the problem, and describes a method for identifying measures that are cost-effective and those that are not. More detailed and rigorous CBAs may be used for situations in which decisions are particularly difficult or contentious.

A CBA is in itself not a decision-making tool, but a risk-informed tool; that is, it provides additional information and insights to decision-makers to help them to make better-informed decisions. It should not be used as the sole criterion for decision-making. In other words, a decision to approve or not approve a mitigation measure is not sound to be based purely on the numeric outcome alone. The robustness of a decision is also maximised if the CBA discusses and lists its assumptions. A key advantage of a CBA is that all assumptions and quantifications are explicitly stated and justified. The veracity of the evidence justifying key assumptions and quantifications can then be fully tested by peer review. This allows stakeholders to better understand the inputs in the analysis and how these affect the final results and decisions.

Not every public space can be fully protected.

A CBA provides a framework to help determine where to draw the line between what to protect and what not to protect.

Risk definition

The standard definition of risk is (ISO, 2018):

$$Risk = \ Likelihood \times Consequences \tag{1}$$

A risk assessment combines these two measures to estimate the overall risk to people, operations and infrastructure. More details of risk assessments are provided in Chapter 3. The nomenclature can vary from discipline to discipline, but in the context of **security** risks for people subject to terrorist attacks, the above terms are defined as follows.

- **Risk.** The risk is estimated for a specific threat that is a potential terrorist attack. This includes the modus operandi and timing of the attack, for example the size of an IED and where and when it is placed or the size and mass of the vehicle and its impact speed.
- **Likelihood.** The likelihood refers to the probability that a terrorist attack is successful in inflicting a loss. This will depend on the modus operandi, ability of the attacker, accessibility, threat history, attack complexity, the importance of the target, people attendance, symbolism, existing measures, and the vulnerability of people and infrastructure if the threat occurs.
- **Consequences.** The consequences are the life-safety, economic and social costs if the terrorist attack is successful. These depend on the exposure, for example the time of day, the location and the scale of the attack, the importance of the target and crowd density, among other things.

The purpose of a CBA is to meaningfully compare actual costs and benefits. Hence, mean or **best-estimate values should be used and not worst-case or overly conservative estimates**.

Risk treatment and proportionality

Evaluating the risk against risk criteria is a method of determining a risk management (or treatment) strategy; it can ensure that actual safety and damage risks to the public are at a level acceptable to duty holders, regulators and society. It is an evidence-based assessment of safety and risk of damage.

Life-safety risks are expected to be controlled to a level that is **as low as reasonably practicable (ALARP)**. The practical implementation of this involves considering risks in terms of the effort, time and money required to control them. There are three categories of risk.

- **Unacceptable.** If the fatality risk is assessed as unacceptable, risk treatment is mandatory except in extraordinary circumstances (e.g. space travel).
- **Broadly acceptable.** At the other end of the scale, fatality risks may be broadly acceptable if they are low or negligible. In this case, reducing the risk is unlikely to be required (unless costs are low), as any benefits are likely to be outweighed by the costs.
- **Tolerable (or ALARP).** Fatality risks are tolerable only if reducing the risk is impracticable (i.e. there is no feasible mitigation measure) or if the cost of mitigation is grossly disproportionate to the risk.

As an example, assume an existing risk of 10^{-4} fatalities per year (or 1 in 10 000). A mitigation measure can reduce that risk tenfold, to 10^{-5} fatalities per year, but at a cost of, say, EUR 1 billion. The mitigation measure would not be preferable if the value of the benefits minus the costs of the measure was less than zero (i.e. the costs exceeds the benefits). If this were the case, other, less costly, mitigation measures could be analysed to check if the fatality risk could be lowered to 10^{-6} fatalities per year so that the value of the benefits minus the costs exceeds zero. The existing life-safety risk would then be deemed tolerable only if all possible mitigation measure failed a CBA.

Costs and benefits are expressed in common units, usually monetary. This provides a consistent basis for comparing the efficacy of various risk mitigation measures. It also gives the decision-making process a degree of transparency. The CBA considers the costs and benefits involved in the whole life cycle of a project.

Proactive and reactive measures

If risks are unacceptable, risk treatment may be needed to mitigate the risk by reducing the likelihood or severity of the threat, decreasing vulnerability, or reducing the exposure and/or the potential consequences. Risk treatment may include:

- proactive measures (reducing the likelihood of the event);
- reactive measures (mitigating the consequences of the event).

Suitable mitigation measures may be identified through the risk identification process. Mitigation measures for events, buildings and other infrastructure may include, for example:

- blast-resistant materials and structural elements;

- bollards or barriers to increase stand-off from VBIEDs;
- protective shields or walls;
- security checkpoints along the perimeter of the site or at the entrance of the event.

See Chapter 4 for more details of risk mitigation and other protective measures.

However, t is not possible to completely eliminate the risk.

Risk transfer is an important consideration for intentional actions, as if a threat is deterred from one site the hazard may simply be transferred to another target, with little or no reduction in risk for society (ISO, 2020). The displacement or transfer of risk essentially means that any effort to protect a target from a terrorist attack or to deter an attack on a target puts other targets at increased risk. This may be an acceptable policy if the risk will be transferred to targets that are less critical to the functioning or well-being of society.

Reducing the probability of the threat would be the most effective countermeasure to reduce the safety and damage risks of attacks on public spaces. Protective measures are only the last line of defence; they are akin to the French Maginot defensive fortifications along the French/German border, which were built to counter a specific threat and were circumvented by an adaptive adversary. Therefore, protection against terrorism threats is best provided by active measures: policing, intelligence and other counterterrorism measures to deter, foil or prevent a terrorist plot.

Proportionality and life-safety

As discussed in the 'Risk treatment and proportionality' section, a **key concept of ALARP is minimising the life-safety risk** while ensuring that the cost of mitigation is not grossly disproportionate to the risk. For example, when considering whether or not to implement measures against risks that are ALARP, the UK Health and Safety Executive advises that the measure must be adopted unless the sacrifice is **grossly disproportionate** to the risk.

The concept of proportionality is not precise. The EU defines proportionality as the principle that, to achieve its aims, it will take only the action it needs to, and not more (European Commission, 2022). This may be interpreted as an action that is not grossly disproportionate to the risk.

A measure is cost-effective if the benefits outweigh the costs. However, even if the costs outweigh the benefits, a mitigation measure could still be reasonably practicable to introduce; that is, when balancing costs against safety, a CBA calculation always favours life-safety. How much costs can outweigh benefits before being judged grossly disproportionate depends on the factors surrounding the safety risk. The UK Health and Safety Executive provides some guidelines on the **disproportionate factor (*DF*)**, noting that a *DF* of 3 is common in workplace environments but may reach as high as 10 in some circumstances (HSE, 2021). To err on the safe side, a *DF* of 10 may be appropriate for antiterrorism mitigation measures where public safety is paramount. This also allows a degree of risk aversion to be introduced into the analysis.

A life-saving measure may be classed as reasonably practicable unless the costs are grossly disproportionate to the benefits. A measure is cost-effective if:

$$\frac{Costs}{Life-saving\ benefits} < 1 \times DF \tag{2}$$

Hence, if *DF* = 10, a life-saving measure would be cost-effective even if the costs were up to 10 times higher than the life-saving benefits.

The *DF* is applied only to life-saving benefits and not to benefits arising from reduced infrastructure damage or other direct or indirect economic losses.

Cost–benefit framework

Qualitative analysis

It is good practice to have an approximate qualitative understanding of the costs and benefits of a risk mitigation measure (see also EIB, 2021). If the costs are not considered high, there is no significant loss of personal liberties and the benefit of reducing the risk is tangible, implementing the security measure is proportionate to the risk (Guikema, 2010).

If the costs or consequences are considered high, quantitative analysis, as a more rigorous assessment is recommended.

Quantitative analysis

The benefit of a risk mitigation depends both on the extent to which it reduces the risk of threat and the extent to which it reduces the consequences of the threat if it occurs. This first requires the existing risk to be quantified.

Likelihood and consequences are interdependent. Terrorists aim to achieve desired consequences or a desired impact. The greater the desired impact, the lower the likelihood of the attack. Therefore, it is important to quantify the consequences of each attack scenario. For example, if the consequences of a sophisticated and well-planned attack (e.g. using a VBIED) are deemed to be hundreds of fatalities, the likelihood of such an attack is likely to be lower than an attack scenario involving a few fatalities, such as a lone attacker knife attack. The attack scenario should be described accurately and comprehensively in qualitative terms.

Likelihood

The likelihood of a successful attack is guided by past experiences (from incident databases) and expert opinions about scenarios, social trends and threat analyses. This is normally undertaken by the security services and police, often in cooperation with personnel knowledgeable in the operation, security and emergency management of public spaces. For a broader discussion on this, see Chapter 3.

The following description of threat likelihood is adapted from *Working with scenarios, risk assessment and capabilities in the national safety and security strategy of the Netherlands* (Ministry of Justice and Security, 2009). It also provides guidance on eliciting expert opinions. This approach is only one example. A more generic framework is presented in Chapter 3.

The likelihood is expressed as the chances of a successful attack occurring within 5 years, and may be obtained from words of estimative probability (see Table 12). Each category can be broken down into three subcategories: low, medium and high. The medium subcategory should be selected if the

likelihood is based on the qualitative descriptions given in Table 12. Upper and lower limits may be selected to represent the uncertainty of a threat, and the sources of uncertainty and unreliability of the estimate need to be described.

It is important to note that, while the likelihood of the threat may be high for a specific country or region, the likelihood that a specific item of infrastructure will be attacked is low (see also Chapter 3). For example, while an attack on a metro system may be deemed 'very conceivable', the likelihood that a specific station will be attacked will be lower, as there are multiple stations in a metro system. This assumes, of course, that the threat information is not specific to the intended target.

Table 12: Likelihoods of threats

Category	Subcategory	Likelihood of occurring in the next 5 years (%)	Threat	Likelihood
A	Low	< 0.005	No concrete indication, but the event is deemed inconceivable	Very unlikely
	Medium	0.005–0.02		
	High	0.02–0.05		
B	Low	0.05–0.1	No concrete indication, but the event is deemed far-fetched but conceivable	Unlikely
	Medium	0.1–0.25		
	High	0.25–0.5		
C	Low	0.5–1	No concrete indication, but the event is deemed conceivable	Possible
	Medium	1–2.5		
	High	2.5–5		
D	Low	5–10	The event is deemed very conceivable	Likely
	Medium	10–25		
	High	25–50		
E	—	50–100	Concrete indication that the event will take place	Very likely

Source: Adapted from Ministry of Justice and Security (2009).

The likelihood that an attack will be successful is determined partly by the vulnerability of the expected target. Table 13 shows examples of vulnerability scores and their descriptors for this specific methodology. If vulnerability is assessed as high, the threat likelihood category is increased by one (e.g. B becomes C). On the other hand, the category is decreased by one (e.g. B becomes A) if vulnerability is low. Guidance on vulnerability scores is provided in Table 14.

Table 13: Vulnerability score

Vulnerability score	Description of vulnerability

		Low	High
Low		A high level of resistance to the threat. Policy is converted into a comprehensive programme of administrative measures, including to ensure compliance	
Medium		Adequate resistance to the threat, but a few weak points regarding measures and/or compliance.	
High		Insufficient or no resistance to the threat. No policy or policy has been inadequately converted into actions.	

Table 14: Guidance on vulnerability score

		Low	High
External threat	Locations	Completely enclosed location with a limited number of entrances Access control and registration Security cameras or other intrusion surveillance	Multiple uncontrolled entrances; incomplete fence Public roads at location No security cameras
	Buildings	Enclosed building with one guarded entrance Identification and registration (personnel, visitors and contractors) Building technical/electronic anti-intrusion measures Compartmentalisation/zones	Multiple entrances Inadequate control and registration No intrusion surveillance Multiple users
	Transport	Intrusion security; immobilisers Global Positioning System Driver security training Procedures with regard to route, route changes, incidents, parking, etc. Use of guarded parking	No security No specific driver training No procedures with regard to route, parking, incidents, etc.
Insider threat		Screening of personnel and employees of third parties Strict rules for hiring contractors and temporary personnel	No screening or investigation of background of personnel or employees of third parties Extensive use of contractors and temporary workers

	Open communication; good personnel policy	Poor personnel policy; poor working atmosphere
	Good awareness among personnel of anything suspicious	No supervision/procedures with regard to sensitive information

Source: Ministry of Justice and Security (2009).

Consequences

The consequences of a successful terrorist attack may include:

- direct costs including loss of life, injuries and physical damage;
- indirect costs such as loss of employment, business losses, loss of service, loss of tourism and reduction in gross domestic product (GDP);
- social losses due to fear and anxiety within society (and perhaps loss of civil liberties), and any psychological or political effects.

The differentiation between indirect and social losses is not precise; for example, a fearful public may be reluctant to travel, contributing to business and tourism losses, or may be reluctant to invest. Total losses from such attacks are significantly affected not by the value of lives lost or physical damage but by the fear they generate, which can lead to large indirect and social losses.

The consequences tend to be monetised to enable a comparison of costs and benefits. Other consequences, such as reputational damage, may be more difficult to express in monetary units.

If the consequences are monetised, risk is expressed as an **economic risk**, such as euros per year. For example, if there is a 1 in 100 chance of a terrorist attack occurring in a year, and the consequences equate to USD 250 million, the economic risk is 1/100 × EUR 250 million = EUR 2.5 million per year. Alternatively, the consequences may be expressed as lives lost; hence, if the consequences are 500 lives lost, the **fatality risk** is 1/100 × 500 = 5 fatalities per year.

The most contentious issue is placing a monetary value on human life. The value of preventing a fatality is often referred to as the value of a statistical life (VOSL). The concept of the VOSL is widely used by regulatory agencies worldwide to decide the cost-effectiveness of government public policies. The OECD (OECD, 2012) recommends a VOSL for the EU in the range of USD 2.4 million to USD 7.4 million, with a base value of USD 4.9 million (adjusted for inflation to 2020). The fear and uncertainty that terrorism invokes suggests that the VOSL will be in the upper range, rounding up to EUR 6.5 million. It is important to note that this is not the value of a life, but 'the value that society deems economically efficient to spend on avoiding the death of an undefined individual' (European Commission, 2014).

The UK Health and Safety Executive suggests that a permanent incapacitating injury be valued at near 20 % of a fatality (HSE, 2020). This estimate allows for extra healthcare costs, hospitalisation, long-term care and incapacity for work. The ratio of major injuries to fatalities is highly variable and is dependent on the threat scenario (explosives, vehicles, bullets, etc.). A starting point for analysis is to assume that this ratio is 1 (one serious injury for every fatality), with lower and upper limits of 0 and 5.

Table 15 summarises some of the important consequences.

Table 15: Checklist of consequences of terrorist attacks and their quantification

Type of loss	Consequence	Value
Life-safety	Fatalities (VOSL)	EUR 6.5 million
	Serious injuries (20 % of VOSL)	EUR 1.3 million
Damage to property	Damage to buildings and infrastructure	Rebuilding value (including clean-up costs)
	Damage to inventory, plants and vehicles	Replacement value
Financial loss	Costs of business interruption due to damage, labour shortage or unusable premises; repair period is an indicator of commercial loss	Gross or net value added
	Business interruption costs due to lack of demand or supply	Gross or net value added
Social losses	Community impact; disruption to everyday life; limited or no access to public amenities, public transport, roads, schools, work or shops	
	Behavioural and psychological reaction generated by fear; avoidance behaviour; reluctance to travel or invest or deviate from usual activities.	Reduction in GDP
	Blame and lack of trust in the government and public authorities	
	Loss of civil rights if new security measures are implemented	
Reputational damage	Negative coverage causing public outcry	

Exposure to the threat is an important consideration in loss estimation, as the timing of an attack affects the number of people exposed to the hazard and the criticality of the infrastructure in terms of business or supply and service interruptions. For example, an IED attack on a government building at the weekend or at night will result in fewer fatalities than a daytime attack on a weekday, as fewer people will be at work and therefore fewer people will be exposed to the explosive hazard.

It is relatively straightforward to estimate the cost of physical damage if the extent of the damage is known. The estimation of the indirect and social consequences of extreme events such as terrorism or natural hazards has been well studied and guidelines for this purpose are available (e.g. Sandler and Enders, 2005).

However, a unique feature of terrorists is their desire to terrorise or psychologically affect their targets, whether they be individuals, society or the government (see also Chapter 2). These

consequences may be difficult to quantify. However, caution is called for so as not to magnify these consequences, which are often self-inflicted after such an attack; for example, shutting down a mass transit system, or closing shops, restaurants, theatres or other places of public assembly for days/weeks following an attack may dramatically increase the consequences of an attack. Individual and societal resilience will reduce the consequences of such attacks (e.g. Mueller and Stewart, 2011).

Case study: consequences – 9/11 attacks on the World Trade Center

The attacks on the World Trade Center caused close to USD 250 billion (inflation adjusted to 2020) in total losses, including USD 20 billion for loss of life (VOSL = USD 7.5 million), USD 40 billion in direct physical damage, including rescue and clean-up costs, and USD 175 billion (equivalent to 0.8 % of GDP) in social and indirect losses to the economy due to people's reluctance to travel or invest, people feeling hesitant about the future and other risk-averse behaviour (Mueller and Stewart, 2011). The 9/11 attacks on the World Trade Center are very much an outlier in terms of losses from terrorism, and are the largest in history.

Table 16 shows the estimated total economic consequences, including loss of life, of major terrorist attacks in Europe and the United States. Most attacks generate economic losses of no more than several billion US dollars or euro. The box below shows a detailed analysis of consequences of the 2016 bombings at Brussels Airport and Maelbeek metro station.

Case study: consequences – bombings at Brussels Airport and Maelbeek metro station

The suicide attack in March 2016 on the departure hall at Brussels Airport, reputedly accomplished using nail bombs in two large suitcases, not only killed 16 people but also caused extensive damage to the check-in area of the airport. After the attack, flights originally heading for Brussels were diverted. The airport partially reopened 2 weeks after the attack, normal services were resumed within a month and the reconstruction of the terminal was completed in about 6 months. The costs of the damage to the airport are estimated to have been EUR 93 million. In addition, Brussels Airlines says that it lost between EUR 4 million and EUR 5 million a day during the height of the disruptions. When extrapolated to many weeks, or months, and for other airlines, the drop in airline revenue could easily exceed several hundred million euro. An economic impact assessment undertaken by the Belgian government found that the airport attack, and the bombing of a metro station that occurred 1 hour later, killing 16 people, caused Brussels to experience a EUR 122.5 million drop in sales in the second quarter of the year, with the regions suffering a further EUR 53 million drop in sales. In addition, Belgium saw a 0.1 % reduction in GDP, or a loss of EUR 760 million. As expected, the biggest losers were hotels, restaurants and tourism businesses, which saw tourism reduced by 2 % across Belgium; however, international tourism increased by 7 % the following year. The costs of damage to the Maelbeek metro station are estimated to have been EUR 67 million. Another EUR 136 million was spent on medical and surgical treatment for the over 300 injured victims. Finally, we conservatively add EUR 208 million for loss of life based on a VOSL of EUR 6.5 million per life.

Therefore, in total the losses from the 2016 Brussels bombing attacks amount to upwards of EUR 2 billion (inflation adjusted to 2020; Stewart and Mueller, 2018).

Table 16: Total economic consequences, including loss of life, of large terrorist attacks in Europe and the United States

	Year	Fatalities	Loss of life (USD)	Total economic loss (*) (USD)
Europe				
Madrid train bombings	2004	191	1.4 billion	3 billion
London transport bombings	2005	52	400 million	5 billion
Oslo bombing and shooting	2011	77	600 million	1 billion
Paris bombing and shootings	2015	130	1 billion	4 billion
Brussels airport and metro bombings	2016	32	250 million	2 billion
Nice truck attack	2016	86	700 million	3 billion
Westminster vehicle ramming and stabbing	2017	5	40 million	500 million
Manchester Arena bombing	2017	22	160 million	500 million
London Bridge vehicle ramming and stabbing	2017	8	60 million	500 million
London Bridge stabbing	2019	2	15 million	100 million
United States				
LaGuardia Airport bombing	1975	11	75 million	250 million
World Trade Center bombing	1993	6	45 million	1 billion
Murrah Federal Building bombing	1995	165	1.2 billion	3 billion
9/11: World Trade Center	2001	2 751	20 billion	250 billion
9/11: Pentagon	2001	184	1.2 billion	10 billion
9/11: United Airlines Flight 93	2001	40	300 million	5 billion
Fort Hood shooting	2009	13	95 million	100 million
Boston Marathon bombing	2013	3	25 million	500 million

(*) Approximate or best estimate.

Source: Global Terrorism Database; Mueller and Stewart (2016).

Risk reduction

The risk reduction (ΔR) is the degree to which the security measure foils, deters, disrupts or protects against a terrorist attack.

The *ΔR* from a protective measure can be estimated in two ways:

- If the protective measure reduces the vulnerability score (see Table 13) by one level, for example from high to medium, this represents a tenfold reduction in risk, leading to a *ΔR* of 90 %. If the protective measure reduces vulnerability by two levels (from high to low), *ΔR* is 99 %. These are substantial reductions that may be expected from effective countermeasures that deal with a specific threat, such as the installation of bollards or security screening of people entering a building.
- Alternatively, expert opinions may be utilised if the vulnerability scores in Table 13 are not appropriate. One way of doing this is to infer *ΔR* from words of estimative probability, as, for example, developed by United States' Office of the Director of National Intelligence (see Table 17); these may be applied to reductions in threat or vulnerability. These are similar to the Professional Head of Intelligence Assessment probability yardstick, developed in the United Kingdom for the Joint Intelligence Organisation (PHIA, 2019). For example, if a protective measure is 'very likely' to reduce threat likelihood or vulnerability, *ΔR* is 85 %, with lower and upper bounds of 80 % and 90 %.

Few, if any, risk mitigation measures are 100 % effective against all threats; hence, some level of loss is anticipated and decision-makers should acknowledge that expecting a risk-free asset is not realistic.

Table 17: Words of estimative probability

Almost no chance / remote chance	1–5 %
Very unlikely / highly improbable	5–20 %
Unlikely/improbable	20–45 %
Roughly even chance / roughly even odds	45–55 %
Likely/probable	55–80 %
Very likely / highly probable	80–90 %
Almost certain / nearly certain	95–99 %

Source: ODNI (2015).

Costs

Usually, the costs and benefits are not constant over time. Security measures tend to incur a high initial capital cost, and then lower recurring costs, for example maintenance costs, in each subsequent year. Benefits can also vary from year to year, though they are more likely to be fairly constant. The 'cost checklist' box provides more details on cost assessment.

CBA results should be presented in terms of annualised values (European Commission, 2014). The annualised value of a cost (or benefit) is calculated as:

$$AV = \frac{PV \times r}{1-(1+r)^{-t}}$$ (3)

where *AV* is the annualised value over time (*t*) in years, *PV* is the present value (sum of all costs over time *t*) and *r* is the social discount rate.

The European Commission recommends using a social discount rate of 5 % for major projects for cohesion countries and a rate of 3 % for the other Member States (European Commission, 2014). However, the Commission notes: 'Member States may establish a benchmark for the SDR [social discount rate] which is different from 5 % or 3 %, on the condition that: i) justification is provided for this reference on the basis of an economic growth forecast and other parameters; ii) their consistent application is ensured across similar projects in the same country, region or sector' (European Commission, 2014). Ultimately, however, the selection of social discount rate is a matter for the relevant decision-makers to determine and justify.

Costs checklist

It is important to ensure that all the appropriate costs have been included and to challenge costs where they appear extraneous or excessive (HSE, 2020).

- Include the costs of equipment, installation, operation, training and any additional maintenance, and the business losses that would result from putting the measure in place.
- All claimed costs are those incurred by the duty holder and costs incurred by other stakeholders and parties.
- The costs considered should only be those necessary and sufficient for the purpose of implementing the risk-reducing measure (e.g. no gold plating or deluxe measures).
- Ongoing business or other losses (or sacrifices) as a result of implementing the measure can be counted.
- Any savings as a result of implementing the measure (e.g. reduced operational costs) should be offset against the above costs. These are not considered safety benefits but are counted as 'cost savings'; that is, they reduce the overall cost of implementing a measure.
- Translation into monetary costs is often uncertain and all costs should be justified.

Source: HSE (2020).

Cost–benefit analysis

The existing risk represents the 'business as usual' or 'do nothing' scenario that is the risk before risk mitigation measures are implemented.

The **benefit** of a protective measure is the reduction in risk (likelihood or consequences) associated with the protective strategy in terms of lives saved and damages averted.

$$Benefit = \Delta R \times Existing\ risk \tag{4}$$

Mitigation measures should result in a proportional *ΔR* that may arise from a combination of reduced threat, vulnerability and/or consequences or exposure. For instance, installing vehicle bollards may

reduce structural vulnerability as well as threat likelihood (if terrorists believe a target is strengthened, they may select a less protected or 'softer' target). For any risk mitigation measure the proportional *ΔR* can vary from 0 % to 100 %.

A measure is cost-effective if the benefits are greater than the costs of the protective measure. The European Commission recommends the use of net present value (NPV) to select the most cost-efficient mitigation measure (e.g. European Commission, 2014). This is equal to the benefit minus the cost:

$$NPV = Benefit - Cost \tag{5}$$

If the annual fatality risk is not broadly acceptable, the decision analysis is ordered into two tiers (see Figure 34).

Tier 1 – A mitigation measure is cost-effective if the life-saving benefits exceed the cost:

$$NPV = \left[\Delta R \times Likelihood \times DF \times L_{\text{life-safety}} \right] - Cost \tag{6}$$

Tier 2 – If Tier 1 is not satisfied, then the CBA can be extended to include direct and indirect consequences:

$$\text{Tier 1: NPV} = \left[\Delta R \times \text{Likelihood} \times DF \times L_{\text{life-safety}} \right] - \text{Cost} NPV = \left[\Delta R \times Likelihood \times \left(DF \times L_{\text{life-safety}} + L_{\text{economic}} \right) - Cost \right] \tag{7}$$

where *DF* is the disproportionate factor, $L_{\text{life-safety}}$ are the life-saving consequences (or losses), and L_{economic} are the direct and indirect economic consequences.
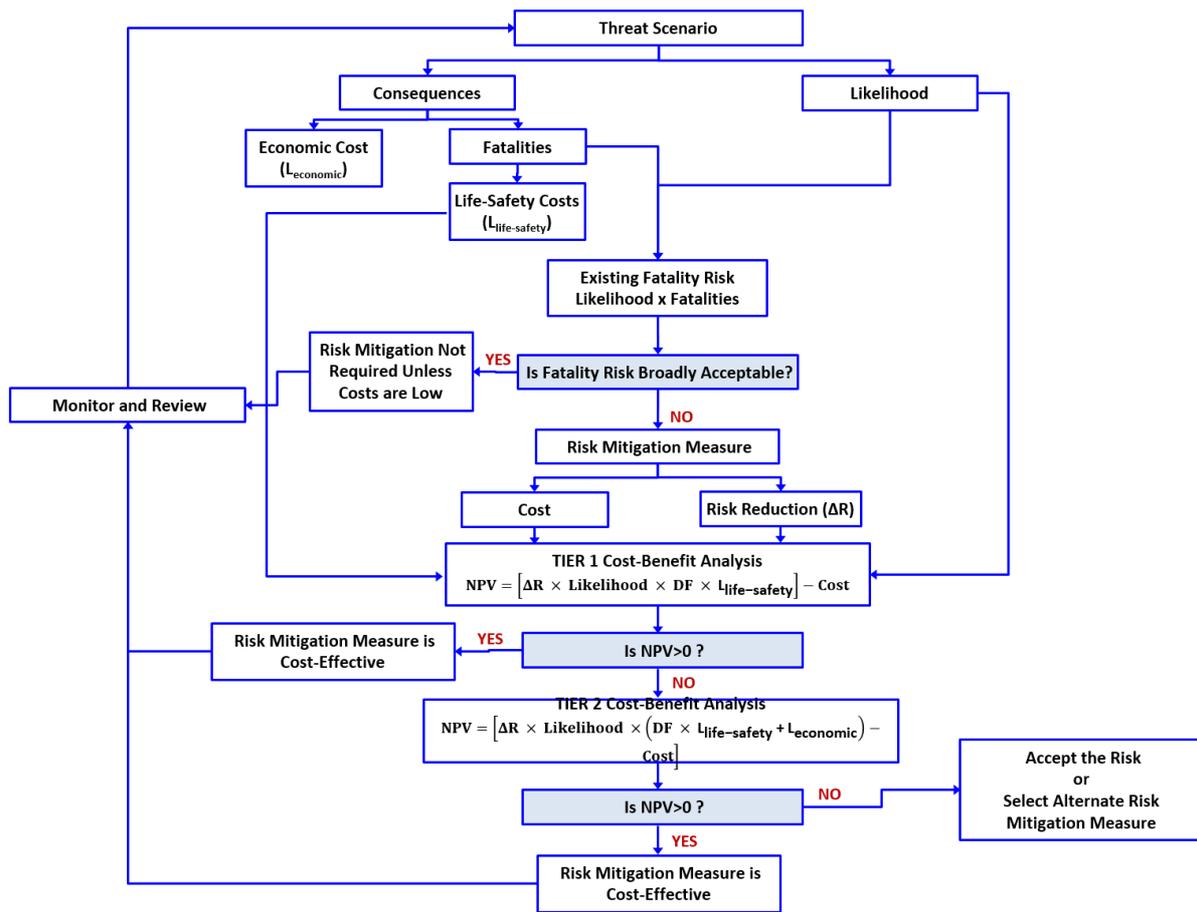
Figure 34: Flow chart of decision analysis

The costs also necessitates the inclusion of opportunity costs and the costs of other unintended consequences of security measures. For instance, installing bollards around a public square may limit emergency vehicle access, or setting up security checkpoints at a building's entrance may result in a bottleneck in the event of the mass evacuation of a building. There may also be a reduction in civil liberties. On the other hand, security measures may have co-benefits, such as providing street furniture, enhancing vegetation or aesthetics and reducing crime, and these benefits can be deducted from the costs.

The box below provides an illustrative application of a CBA.

Application of CBA

The following scenario involves the placing of vehicle barriers (bollards) in a hypothetical public square to protect against a vehicle ramming attack.

The example and quantification of parameters is heuristic and will highlight the type of information that is required for the CBA of a security measure. The results are **illustrative** only and should not be used for regulatory decision-making.

Assume that there is no physical protection of the public space to prevent a vehicle entering the space and causing mass casualties as a result of vehicle impact. Hence, the existing vulnerability is high.

In addition, assume that the consequences of a successful attack are 12 fatalities and 12 serious injuries.

The annual likelihood is assessed as 0.5 % (see Table 18). The fatality risk is therefore 0.5 × 12, which amounts to 0.06 fatalities per year. This is deemed unacceptable; therefore, risk mitigation is mandatory. Table 18 summarises the inputs and the Tier 1 and 2 CBAs. In this hypothetical case, the *NPV* is EUR 2.4 million per year for a Tier 1 analysis that focuses on the life-saving benefit of the protective measure. As expected, if the economic savings are also included then this increases cost-effectiveness, leading to an *NPV* of EUR 7 million per year. Therefore, in this case installing bollards would be deemed to be cost-effective.

Table 18: Summary of CBA

CAB step	Parameter	Value	Comment
Consequences	Fatalities (12)	EUR 78 million	VOSL = EUR 6.5 million
	Serious injuries (12)	EUR 16 million	EUR 1.3 million per serious injury
	Physical damage	EUR 10 million	
	Indirect and social losses	EUR 1 000 million	
	Total		
	Life-safety	EUR 94 million	$L_{\text{life-safety}}$ (fatalities and serious injuries)
	Economic	EUR 1 010 million	L_{economic} (damages, and indirect and social losses)
Vulnerability	Existing measures	High	
	With security measures	Average	
	ΔR	90 %	Tenfold reduction in risk
Likelihood	B – medium	0.25 % per 5 years	For average vulnerability
	C – medium	2.5 % per 5 years	High vulnerability
			2.5 % divided by 5 years
	Annual likelihood	0.5 % per year	
	Annualised cost	EUR 1.8 million	Equation 3
NPV	Tier 1	EUR 2.4 million per year	Equation 6, *DF* = 10
	Tier 2	EUR 7.0 million per year	Equation 7, *DF* = 10

Sensitivity analysis

A sensitivity analysis consists of varying one or more of the parameters/assumptions of the CBA and determining the effect on outcomes (HSE, 2021). The EU *Guide to Cost–Benefit Analysis of Investment Projects* (European Commission, 2014) notes that 'Sensitivity analysis enables the identification of the "critical" variables of the project'. Hence, it is important to undertake a detailed sensitivity analysis of input parameters to assess their influence on the final result. These approaches are able to test the robustness of a decision (see the example in the box below).

The likelihood assessed below indicates a 0.5 % annual likelihood. The sensitivity analysis may be completed with a scenario analysis, where combinations of 'optimistic' and 'pessimistic' values are used to ascertain if the decision holds under certain hypotheses. Optimistic and pessimistic values may be taken as lower and upper bounds (extremes) of values. Hence, if NPV remains positive, even in the pessimistic scenario, the confidence in the decision can be assessed as high.

Example of a sensitivity analysis

After conducting a CBA, a sensitivity analysis is conducted to test the robustness of the results. In the sensitivity analysis in Table 19, inputs are changed based on optimistic and pessimistic assumptions. For instance, if the social and indirect losses are deemed to be overestimated by a factor of 4 (to EUR 250 million), then the analysis yields a strongly positive NPV. In all cases, even when inputs are varied by 50 % or 100 %, the NPV remains higher than zero, suggesting that the protective measure would be cost-effective even under pessimistic scenarios.

Table 19: Sensitivity analysis

	NPV (million EUR)	
	Tier 1	Tier 2
Reference case (see Table 18)	2.4	7.0
Reduction in cost-effectiveness		
Social discount rate increased to 7 %	2.2	6.7
Indirect and social losses reduced to EUR 250 million	2.4	3.6
ΔR reduced to 25 %	−0.64	0.63
DF reduced from 10 to 3	−0.54	4.0
Threat likelihood reduced to lower bounds of C – medium	−0.12	1.7
Expected number of casualties halved	0.3	4.8
ΔR reduced to 50 %	0.53	3.1
No serious injuries	1.7	6.3
Maintenance costs increased by 50 %	2.2	6.8
Indirect and social losses reduced to EUR 100 million	2.4	2.9

Increase in cost-effectiveness		
Indirect and social losses doubled to EUR 2 billion	2.4	12.0
Social discount rate reduced to 4 %	2.5	7.1
ΔR increased to 99 %	2.8	7.8
Threat likelihood doubled to upper bound of C – high	6.6	16.0

Key take-aways

There is never zero risk

Risk cannot be completely eliminated and that not every public space can be fully protected. However, risk mitigation measures are prioritised to maximise public security at a reasonable cost that is proportionate to the risk. This can be done minimising the life-safety risk by following a key concept such as 'As Low As Reasonably Possible' (ALARP).

A cost–benefit analysis does not replace decision-making

A CBA is not a decision-making tool. It should not be used as a sole criterion in decision-making and cannot replace it. However, CBA can help in making informed choices between risk mitigation options, can reveal wasteful expenditure and allow funds to be directed to where most benefit can be attained. It is helpful as an initial selection tool for a specific site or a large portfolio of sites and assets. It provides a consistent basis for comparison and fosters transparency in the decision-making process.

Defining an acceptable level of risk

Evaluating specific risks, determined through evidence-based assessments, against predefined and accepted risk criteria ensures that the chosen risk treatment strategies are in line with safety and damage levels acceptable to duty holders, regulators and society as a whole.

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7 Conclusions

Terrorist attacks most commonly target people in public spaces, which are especially vulnerable owing to their open and accessible nature. Attacks targeting crowded public places, and sites of symbolic and iconic value, including places of worship and tourist locations, ushered in a new era in protective counterterrorist planning in Europe and beyond. **The protection of public spaces has therefore become a key counterterrorism priority in the EU**, and **the European Commission remains committed to supporting Member States** by providing them with guidance, among other things.

We wish to safeguard the open nature of public spaces and take preventive measures, while at the same time making them more secure by implementing **better physical protective measures that do not give the appearance of a 'fortress' and still allow citizens in the EU to walk about freely and safely**. Initial protective design concepts focused on very visible, hardened installations at high-risk locations. Once these were protected, a multitude of non-protected, 'soft target' locations became the main focus. This has led to the development of less intrusive solutions that are not focused exclusively on security but also consider other aspects.

Understanding the local context is crucial because the public's perception of terrorism and sensitivity towards protective security measures varies widely. The public's perception also evolves over time in relation to their history and exposure to past terrorist acts. Protective measures shape public spaces' appearance and communicate a message. They may act as a reminder of the terrorism threat but also inform the public of what could reasonably happen, providing guidance on expected behaviour.

Security by design is a new and developing concept. Its key principles, such as the integration of proportionality, multifunctionality, sustainability, accessibility, stakeholder cooperation and aesthetics, ensure that security measures are embedded into the built urban fabric. Accordingly, protective security solutions designed in this manner will be better integrated, more effective and more cost-efficient, and will enjoy wider social acceptability. However, the historical character of European cities and changes in public space use over time, particularly in terms of mobility concepts, greatly influence public space use and present additional challenges in the implementation of the security-by-design concept.

It is essential to adopt an integrative, long-term vision of public space planning, starting with the big picture and involving all relevant stakeholders. A systemic approach considers the macro level that is the city as a whole, as well as, at the micro level, the design of a particular public space. Such an approach creates synergies and promotes the integration of security-by-design principles from the planning stage through to efficient project implementation.

Protective measures call for regular reevaluation, and eventual re-adaptation if they are not to become obsolete. In addition, **the redesign of public spaces, if it is to take account of climate, environment and biodiversity, in line with the European Green Deal and the New European Bauhaus initiative, presents both a challenge and an opportunity** for the integration of specifically designed, multifunctional protective security measures.

Terrorism risk assessment is essential and includes a thorough, structured approach establishing a comprehensive understanding of the influencing parameters accompanied by a risk management framework. While the risk assessment aims to estimate the potential impact, severity and probability of occurrence of terrorist attacks, the risk management framework focuses on the consideration and selection of available options for treating the assessed risk through interventions in different phases, including prevention, mitigation, preparedness, recovery and reconstruction or adaptation.

Risk cannot be completely eliminated, and not every public space can be fully protected. Therefore, a thoroughly designed and carefully executed risk assessment can help in prioritising the public spaces to be protected, revealing the most exposed sites and addressing, through appropriate measures, identified vulnerabilities. In addition, as there is no universally accepted risk assessment methodology for terrorism threat, efforts should focus on identifying potential threats utilising available information, evaluating the consequences of potential attacks and assessing the vulnerability of targets. Prior incidents can also help in establishing indicative values.

Decision-making requires a clear definition of acceptable risk. The evaluation of specific risks, determined through evidence-based assessments, against predefined and accepted risk criteria, ensures that chosen risk treatment strategies are in line with safety and damage levels acceptable to decision-makers, regulators and society as a whole.

The key principles of the security-by-design concept **call for innovative technical solutions for public space protection against terrorist attacks**. This book presents a large variety of technical solutions, influencing factors and case studies, in particular for structural or physical protection against vehicle ramming attacks and explosions. Furthermore, it provides practical guidance on the large variety of available solutions with regard to costs, functionality, implementation constraints, protective capability and social acceptability. In this context, the book also highlights potential 'pitfalls', for example in realistic overall cost prediction, as the physical protective measures may constitute only a fraction of overall costs, and the importance of technical expertise and specialist knowledge for well-calibrated engineering design and choosing adapted protective solutions. EU funded research actions develop further innovative solutions, knowledge and methods for security in public spaces.

Finally, when applying the security-by-design concept, security aspects become an integral part of project planning, requiring project management techniques, tools and methods. In this context, the book provides guidance on relevant project management processes in order to support the efficient and targeted use of resources. It focuses in particular on the importance of spending sufficient time on the initial threat identification process and risk assessment. The root causes of project failure have been demonstrated to be unrealistic or overambitious project planning, unclear or changing objectives, or deficiencies in decision-making due to initially ill-defined risk criteria. Spending time on these aspects is therefore crucial for the project's success.

Contribution

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The following experts have contributed to parts of the document: Jon Coaffee, United Kingdom; Benoit Moritz, Belgium; Ana Veronica Neves, Portugal; Stine Ilum, Denmark; Norbert Gebbeken, Germany; Anke Schröder, Germany; Melanie Schlüter, Germany; Paul Warnstedt, Germany; and Mark G. Stewart, Australia.

Case studies were contributed by Paul van Soomeren, the Netherlands; Randy Bloeme, the Netherlands; Daniel Hedman, Sweden; Petter Säterhed, Sweden; Quentin Verstraeten, Belgium; Hans Crab, Belgium; Olivia Goffin, Belgium; Debora Veluti, Italy; Clarissa Knehs, Austria; Geert Coremans, Belgium; Eduard Carrasco Gonzalez, Spain; and Norbert Gebbeken, Germany.

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Annex: Anthropological and sociological perspectives on terrorism and protective measures

The calculation of the costs and benefits of protective measures should consider not only the technical and financial aspects but also the public's perception of the risk of terrorism and the perceptions of the presence (or absence) of security measures in public spaces.

In this annex, we ask two experts (anthropologist Stine Ilum and sociologist Ana Veronica Neves) from different backgrounds to discuss the issue of social perceptions that decision-makers may find relevant. Instead of providing right and wrong answers, this annex presents different perspectives on the topic of security by design, aiming to provide decision-makers with a toolbox of questions to examine and diverging points of view to consider when making decisions.

Public's perceptions of (counter)terrorism, security and related fear

From an anthropological and sociological perspective, what is most important to know about people's perceptions of (counter)terrorism, fear and security?

S. Ilum: When designing and installing protective measures in public spaces, it is important to keep in mind that the calculated risk of a given threat does not correlate 1:1 with people's perceptions of risk and their feelings of insecurity and fear.

Terrorism is something that many people are concerned about, though the actual risk of being killed in a terrorist attack in the EU is for most of us very small. In other words, when it comes to terrorism, the **perceived** risk is often greater than the **calculated** risk. My research shows that the potential threat of terrorism can affect people's lives in very real ways, for instance how they navigate and experience cities, public spaces and crowded events.

> **Box: relative perception of terrorism risk**
>
> In 2018, 48 % of 14 000 European children interviewed said they were worried about 'the possibility of war or terrorist attacks' (UNICEF, 2018), and in 2017 44 % of 33 000 European adults interviewed saw terrorism as the most important issue faced by the EU (European Commission, 2017). In the past 20 years, fewer than 200 people have been killed by terrorism in Europe annually (European Union Institute for Security Studies, 2017). For comparison, 20 000–50 000 people have been killed in road traffic accidents every year in the EU over the past 20 years (European Commission, 2021).

To make people feel safer, it is therefore not enough to focus on reducing the calculated risk. We should also reduce people's perceptions and feelings of risk, insecurity and fear. While we have quite sophisticated methods for working with calculated risk, for instance by way of structured risk assessments and measures such as surveillance cameras, bollards and other types of protective measures, we call for new insights and methods for working with people's perceptions.

An anthropological approach enables an understanding of how, where, when and why concerns and fears of terrorism are triggered. Moreover, it allows for an

understanding of the everyday lives that potential increased protective measures will undoubtedly impact. It is a situated approach that takes its point of departure in the actual everyday lives of citizens and urban spaces. When working with urban development and protective measures, a basic understanding of the local context and of people's fears and concerns makes it possible to actively engage with them.

Box: 24-hour anthropological study

To get an initial understanding of who uses an urban space or neighbourhood, how, where, when and why, conducting a 24-hour anthropological study (Figure 35) at the beginning of your project is a helpful tool. You do not have to be present for all 24 hours; instead, choose different times across the day that combined will give you a nuanced impression of the space.

Figure 35: 24-hour anthropological study

Print out a map of the area you are working with. Prepare three or four questions that revolve around people's perceptions of the area. Start by taking a walk, observing and noting down: What characterises the area? Physically? Socially? How many people use the different parts of the area? In which ways?

Now, interview people you meet in the streets and use the map to talk around. Some of the questions could be: Which are your favourite and least favourite places in the area? Have you ever felt unsafe? Where and why? Have you ever been concerned about the risk of terrorism? Where and why? Do not forget to take detailed notes.

A 24-hour study can provide initial insights on local user groups, social dynamics, qualities and challenges, which you and your team can further explore and use to inform and shape your project.

A. V. Neves: Space influences and strongly conditions human behaviour

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City planners and urban developers assume a very important role as creators and managers of public spaces. Security solutions have the potential to orient or support human activities, and, at the same time, influence people's experiences in public spaces with context and connotation. An urban project, once implemented, becomes a social space, with history and stories to tell, with a past, a present and a future. The public space is apprehended by its apparent manifestations, by the perceptions of people towards it and not merely by its functionalities. Overprotecting from terrorism can transmit a wrong image of insecurity or create perceptions of 'no go' territories. It is very important to think about the impact urban design has on space users, especially when protecting them from terrorist attacks.

Involuntarily, urban design has often excluded people. For example, instruments/equipment/features/services of everyday use such as buses, buildings, pavements or car parks often do not consider the needs of people with disabilities and condition their participation in urban life. This creates negative images of

particular places and a bad reputation from which it is difficult to escape, even after complete rehabilitation and name changes. Therefore, it is necessary to transmit the idea that protecting people from terrorist attacks cannot turn space into exclusionary areas that repels people.

When designing protection solutions against terrorism threats, space managers (decisions-makers, urban planners, architects, landscape architects and engineers) should consider the effects the security solution will have on people's lives. That is, how the adopted solutions will affect the space usage, given that public spaces require not only to be secure, but also attractive, comfortable, functional and safe. Public spaces reflect the type of society we have and plan on having. Even with protection solutions in place, public spaces should create a perception of peace and harmony and not evoke feelings of alarm, isolation, exclusion and fear.

What is key for a city planner to know before selecting protective measures for public spaces?

S. Ilum: Working with counterterrorism and protective measures is full of dilemmas and different opinions. There is no **one** right solution. Within public institutions and private companies, and among ordinary citizens, perceptions of protective measures and opinions on what is or is not the right solution differ. Factors such as an individual's professional background, political conviction and financial interests, as well as local history, traditions and values, all play a part in shaping these perceptions and opinions.

In my research, I have followed the work of a municipality, a security company and an architecture firm, all working with counterterrorism and protective measures. Employees at the municipality were very concerned about the measures' impact on the openness and inclusiveness of public space, and preferred as few and as integrated measures as possible. Employees at the security company were convinced that the right way to work with security was by thorough risk assessments and certified measures such as steel bollards. Finally, employees at the architecture firm were much more focused on the aesthetics of the solutions and camouflaging them to be part of the urban landscape, for instance by using plateaus, planters and water basins. In contrast to these professionals, the citizens I spoke with in Copenhagen, Oslo and Paris rarely had strong opinions on the topic of counterterrorism and associated protective measures. In my interviews, I found that most citizens notice the presence of concrete blocks, bollards, patrolling guards and other measures, but they do not have strong opinions about them.

In other words, there is no one right solution. Working with protective measures requires weighing up different trade-offs and making decisions, such as: Do we want the smallest risk possible no matter the costs (financial, aesthetic or effect on daily life)? Or do we prefer urban spaces that are not shaped by security considerations (and are we therefore willing to accept a higher risk)? Should protective measures be clearly visible or camouflaged? Temporary or permanent? Certified or not? Do we want to reduce only the calculated risk or also the perceived risk? Such dilemmas can be used as constructive starting points for a discussion as to which solutions may be best for your specific project, considering the local context.

A city planner should make these decisions and be prepared to defend them, which can be hard. As one of my interlocutors from the Municipality of Copenhagen phrased

it: 'If a terrorist attack actually does happen, nobody wants to be the person who said no to more security, but someone has to take that responsibility …. It is about taking responsibility for the public space and city. And asking yourself: What kind of city do we want?'

Constructing a dilemma diagram as a method

Identifying the most prevalent dilemmas at the beginning of a project can help you to prioritise initiatives and focus your efforts. Keep the overall question in mind: What kind of city do we want?
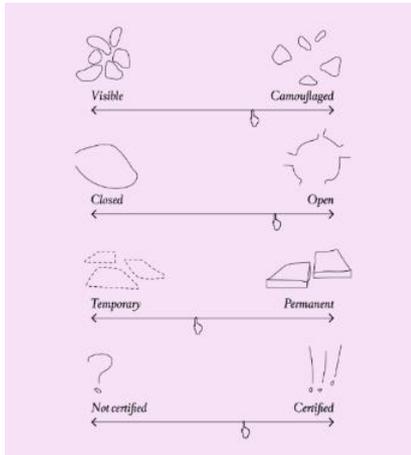

Figure 36: Dilemma as a method

Create a dilemma diagram (Figure 36) and use it as a discussion tool among your colleagues. It is a good idea to gather people with different professional backgrounds (e.g. engineers, city planners, architects, anthropologists and security specialists), as these can illuminate different aspects of (counter)terrorism and security.

This list of dilemmas is just an example. Each project will have its own inherent dilemmas, which can be important guiding principles for a project's development. Dilemmas do not always offer a choice between two alternatives; you may be able to creatively combine functions and rethink possibilities.

A. V. Neves: Political support is, ultimately, the foremost determining factor of the level of investment a city is willing to make to protect its public spaces. Identifying the vulnerability of buildings, spaces or infrastructures through risk, threat and vulnerability assessments is a fundamental task, as described in Chapter 3.

It should be emphasised that the protection of public spaces is not an isolated task. In the planning of public spaces, terrorism protection is one concern among many others, such as aesthetics, inclusivity, accessibility or sustainability. The creation of public spaces requires a holistic approach involving a wide range of professionals. Space users, usually denominated as 'native experts', the public and the decision-makers (political support) should be involved in all stages of a project. Nevertheless, in the case of protection against terrorism, not everyone should know everything; that is, information is distributed on a need-to-know basis.

A city planner ought to recognise the call for a multidisciplinary approach to protect public spaces from terrorism threats. Stakeholders such as community police officers, representatives of local institutions, local businesses and neighbourhood associations provide important information to local authorities, who work together with specialised counterterrorism police forces. A cohesive community creates a better environment for detecting suspicious behaviour. Working in close relationship with the police can make a significant difference when assessing the design and the installation of protection solutions.

Involving citizens and communities in the protection of spaces they claim as their own and deepening their feeling of ownership results in more sustainable and effective protection. It is a win–win situation. Because not everyone is connected and engaged, social work is fundamental to prepare the community for it. For example, the municipalities of Lisbon and Seixal in Portugal promote effective community participation in urban rehabilitation to improve public spaces, for example in installing drinking fountains, shades, barbecues or removing graffiti. Community and local institutions such as professionals from the municipality, the police and private business representatives work together increasing the levels of social cohesion and common trust, something which can be applied to terrorism protection as well.

Ignoring the social dimension can jeopardise the entire project. This is the reason why there cannot be universal solutions. The historical, cultural and political backgrounds determine the level of acceptance of terrorism protective measures, and these can be different across communities, cities, regions and countries.

Therefore, considering that there is political support, a city planner should understand the call for a multidisciplinary team involved in the protection of public spaces in all phases of the project. Relevant stakeholders, including the public, are involved and informed on a need-to-know basis. Foot patrol police officers, who are the most familiar with the territory, are consulted or included. A city planner does not have to know everything, but should recognise the importance of other professionals who will provide fundamental information. They are all players in the same team with different knowledge and experiences.

Case study: foot patrol community policing in Lisbon, Portugal

This model of policing is based on the will of citizens and local partners to promote safer communities; and to identify and solve common problems through cooperation based on a relationship of trust. The way it works is two police officers foot patrol a territory daily. They have monthly meetings with local partners and residents. The group's activities are guided by a co-devised annual programme which addresses problems like litter, vandalism, discomfort in public spaces, parking and other security issues that impact people's lives

Community policing works with and for the population. It is based on the idea that security depends on everyone. With time, police officers are called by their first name as a result of this relationship. There is no community policing without the community's will or support.

Such a model can be instrumental for informing the terrorism risk assessment process for particular public spaces, but also for planning and designing protective measures which will not be perceived negatively by the community.

More detailed information is available in a video[21] created by the European project Cutting Crime Impact[22].

Do physical security measures make citizens feel more secure or more threatened?

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[21] https://www.youtube.com/watch?v=wX0ZPQ9uCyE&t=63s

[22] https://www.cuttingcrimeimpact.eu/about/introduction-to-cci/

S. Ilum: I have been asked variations of this question more times than any other since I first started working on the topic of counterterrorism. Do visible protective measures make citizens feel secure? Or do they evoke fear? Is it good to integrate them in the surrounding landscape? Or is it better to have visible bollards, cameras and guards? The reason I have been asked this or some version of this so many times, I believe, is because there are many interests at stake here. What is in a citizen's best interests can function as valuable backing in the promotion of different agendas. For actors working with or selling traditional protective measures, the most profitable answer would probably be that clearly visible measures do make people feel more secure. But for actors who develop or promote integrated or camouflaged solutions, the best answer would be the opposite.

I do not believe there is a clear yes/no answer to this question. In the anthropological literature on the relationship between people and the material world, many scholars have shown, and argued, that material things shape people, and vice versa. My research also shows that the physical and social surroundings of a city play a central role in evoking the fear of terrorism. **Therefore, if asked if physical protective measures influence people's lives, my answer would be a clear yes. However, what this influence is precisely is more difficult to say. It depends on the local context, the people in question, and the specific protective measures, which is why I will argue for a more situated approach to understanding and working with protective measures**.

If we start by looking at the literature, scholars across the world have argued that protective measures such as walls can segregate people on a city-wide scale, while measures such as bollards, wedge barriers and surveillance cameras can exclude certain people and behaviours in urban public spaces. This literature argues that protective measures of different kinds can challenge the heterogeneity, openness and stranger sociality often associated with public spaces and cities. Such studies illuminate general impacts protective measures can have on cities, while fewer studies have tried to answer what protective measures make people feel.

Box: emotional reactions to different types of security measures

In 2006, architect Kevin R. Grosskopf conducted a study in which he showed a group of North American students photos of visible protective measures such as barbed wire and vicious dogs, as well as images of integrated measures including fortified benches and lamp-posts. He asked the students to self-assess their emotional reactions and concluded that the students generally had a negative response to visible measures, with the most negative response given to 'living' measures such as the vicious dogs. These same students, on the other hand, responded to the integrated measures in a manner consistent with responses to photos of leisure and relaxation.

Kevin R. Grosskopf, for example, conducted a study during which he showed photos of protective measures to a group of people and asked them to assess their emotional response. In this almost laboratory kind of way, he isolated people, protective measures and emotions from the context in which they would normally occur, not taking into consideration factors such as time or space: Are the measures placed in a crowded train station or a desolate parking lot? In rush hour or on a calm Sunday

noon? In Paris right after the November attacks or in Copenhagen on a peaceful summer day? He concluded that there was a negative response to visible protective measures and a neutral to positive response to more camouflaged solutions. The study is useful to the extent that it points out that most people probably prefer benches and lamp-posts to vicious dogs and barbed wire; however, I believe drawing on such a de-situated study would not be helpful for city planners, who always work with protective measures in very specific contexts.

Box: perceived security in crowded public spaces

In 2016, political scientist Anja Dalgaard-Nielsen and her colleagues interviewed focus groups of people in Denmark, asking them to discuss what would make them feel more secure in relation to terrorism in a crowded urban space. The study concluded that visible measures make people feel more secure, and that some of the concrete factors that increase said feelings of security are 'robust security procedures at transportation hubs (screening, removal of left luggage, etc.)', 'access control at major events' and 'security measures at buildings and crowded places'.

In a different and somewhat-situated study, Anja Dalgaard-Nielsen and her colleagues concluded that the presence of protective measures in public spaces increases people's feelings of security. This study was based on focus group interviews and was a bit more situated in the sense that it set the scenario in which the protective measures occurred. The interlocutors were asked to discuss what would make them feel more secure in relation to terrorism in a crowded urban space. Concluding that protective measures generally make people feel secure may be overinterpreting the findings; rather, one might conclude that protective measures can mitigate fear in already fear-inducing situations.

What I am trying to get at is **if we want to reduce the perceived risk of terrorism, it is too simple to merely ask: Do protective measures make people more or less scared? Rather, we can widen our scope and look at the city as context, and at the factors that more generally trigger people's concerns and fears regarding terrorism. In other words, I call for a situated approach.**

In Copenhagen, I have focused more broadly on the relationship between the aesthetic and sensorial elements of the city, and people's perceptions of terrorism and fear. I have conducted interviews with people both on the streets, navigating actual in-place protective measures, and in people's homes or offices, primarily in Copenhagen but also in Paris and Oslo. I have asked questions about their routines in the city, their least favourite places, if they have ever been worried about terrorism, what has characterised their worries and so forth. **My data have shown that people think about and feel afraid of terrorism in very specific scenarios.** They are not constantly afraid but feel so sometimes, for brief moments, during or at scenarios that remind them of terrorist attacks: on pedestrian streets, and at train stations, Christmas markets and airports. Also, more generally, in scenarios that aesthetically resemble places where terrorism has happened before: an urban setting, surrounded by people in a cramped space, maybe even below ground and/or with a hectic ambience. I have never met anyone who has been worried or afraid of terrorism when walking alone in an empty rural setting or in a desolate part of a city.

Such an in-depth understanding of how, where, when and why people are concerned about terrorism provides the basis for developing a more fundamental approach to reducing the perceived risk of terrorism.

What sparks a fear of terrorism is primarily a combination of two things. First, people see images and stories in the media about terrorist attacks unfolding in certain places around the world, and so they know how such scenarios have occurred and what they look and feel like. Second, they find themselves suddenly in a situation that aesthetically and sensorially reminds them of said previously seen attacks, and therefore realise it could happen again, right there and then. This dynamic may be similar for other types of crime, but **my research has shown that the fear of terrorism occurs in quite different scenarios than fears related to any other type of crime, which is why these fears should be treated differently. Therefore, as a city planner, one cannot use the same tools to reduce citizens' fear of crime and their fear of terrorism.**

I see two sides to the work one could do to reduce people's fear of terrorism. First, try to curb the extreme media flow focused on terrorism by limiting what's added to it. For instance, consider both the negative and positive implications of communicating a (counter)terrorism project widely or asking all citizens to take an active part in security initiatives, such as the American 'If you see something, say something' campaign.

Second, consider giving special attention to some of the places that trigger people's fear. These places surely differ in various parts of the world, depending on the media flow, history of terrorist attacks, urban landscape and so forth. They could, however, be found through a qualitative study asking selected citizens about their routines, memories and feelings about their city, in order to map out where, when, how and why they are afraid of terrorism. Due to the significant role of international media, certain scenarios will surely be the same elsewhere as they are in Copenhagen.

In Copenhagen, it makes sense, strategically, to focus on crowded train stations, pedestrian streets, the airport and crowded events, to work on changing their aesthetics to make them feel less cramped; to brighten them up; to spread out crowds; and to add elements that may be conducive to a more relaxed and positive ambience (e.g. by drawing people's attention to things other than crowds and the risk of terrorism, be they interesting artworks, architecture, flowers, trees, soundscapes or smells).

These suggestions do, however, bring me back to the point that working with counterterrorism is about making choices about what city people want to have. Because maybe cramped and hectic places are also part of a particular city's charm? Maybe standing in a huge, sweaty crowd is what a great concert is actually all about? Maybe moving at a fast pace through metro tunnels, surrounded by thousands of other commuters, is precisely what's so alluring about a buzzing city? You can thus make various initiatives to reduce people's concerns and fears regarding terrorism, but these may also reduce some of the qualities inherent to city life. Again, working with protective measures requires weighing out different trade-offs and making decisions.

A. V. Neves: Public spaces should attract pedestrians by providing security, comfort, vitality and tranquillity in an environmentally friendly set-up. It is a difficult challenge maintaining the balance among all these prerequisites. The way security measures are designed within and integrated into public spaces determines the way people perceive them, from reassuring to alarming.

An overprotected space or building 'screams': 'I have something valuable and I am protecting it. Stand off!' **Disproportionate measures feed negative social feelings. There should be a balance between the protection measures and the impact these measures have on people's lives.** The ideal is to have protective street furniture 'subtly embedded within the cityscape' (GCDN, 2018, p. 7), proportional to the assessed threat. Hostile architecture can be implemented exceptionally in some situations, but cannot be the norm and depends on the level of threat.

This image transmits the idea that the level of threat is high and authorities are alert and concerned. Pedestrians feel the danger.

Feelings and perceptions in urban space are triggered by the environment and by personal experiences. Protection solutions should be subtle.

Barriers or roadblocks and bollards, initially created to control traffic create, in fact, trigger perceptions such as exclusion much more than protection (Schindler, 2015).

The famous New Jersey barriers, once described as 'architecture of dis-assurance' (Boddy, 2007, p. 278) were developed to create an idea of change in the fight against terrorism after 9/11 around Washington and Lower Manhattan. They changed the urban landscape, even if some authors argue that they may be dysfunctional in certain contexts (Boddy, 2007).

Solutions should be proportionate. They should gracefully protect without obstructing the vitality of the public space, providing both comfort and security.

It is difficult to predict human behaviour, especially in extreme situations such as terrorist attacks. A special attention should be addressed to community readiness for such situations. Regular drills can orient behaviour in case of an attack. These drills, however, require careful communication to avoid transmitting the idea of an imminent threat.

This is an example of a protection solution that is also functional and aesthetically integrated so that it does not evoke feelings of the presence of an imminent threat.

In the protection of public spaces, solutions should be thought as 'soft on the outside, hard within, the iron hand inside the civic velvet glove' (Boddy, 2007, p. 291) that is resistant or robust and effective, but unnoticeable for space users.

Can awareness raising among citizens reduce fear and insecurity?

S. Ilum: My research shows that the broadcasting of international terrorist attacks in the media plays a key role in evoking the fear of terrorism. When people move around the city, they are reminded of these previous attacks, and those reminders negatively impact their city lives. This is not just the case in cities where actual terrorist attacks have taken place but also in other cities, where people only know

about such attacks though media consumption. Fear of terrorism is thus transported via and enabled by the media and communication.

I would therefore say that minimising communication about terrorism is the best possible cure to this widespread fear. This is of course a larger task than any city planner can take on, but we cannot omit the central role that the media play in this issue. If the media reduced their extreme attention to everything concerning terrorism, and if researchers like myself could curb the continuous flow of information about terrorism, I believe people would worry less about it.

During 2 months of my daily life in Copenhagen, I noted every time I heard the words 'terrorism' or 'counterterrorism' outside of work, just to get an idea of how much people are exposed to the phenomenon. I heard one or both of them almost once a day. So when asked whether raising awareness among citizens can reduce fear and insecurity, my answer would be a clear no. In fact, I would say quite the opposite: people today are too aware of terrorism. The many little reminders they get on a daily basis may collectively be the reason so many people worry about terrorism in the first place.

What a city planner can do is not add to this media flow by not communicating unnecessarily about (counter)terrorism and protective measures. Not communicating about terrorism is not the same as not understanding and involving the citizens in urban development. On the contrary, city planners should visit, understand and engage more with the local environment and the lives of those their work impacts in order to develop (counterterrorism) projects that support citizens' everyday lives, ideas and routines.

If we return to the previous question about visible protective measures and embrace the strategy that minimal communication about terrorism is the best way forward, then the protective measures themselves should also communicate as little about terrorism as possible. Almost everyone I have spoken to in Paris, Oslo and Copenhagen has noticed the different protective measures in various urban spaces and knows their purpose. Thus, it is safe to say that most protective measures communicate their purpose, namely protection against terrorism. This type of communication, of course, adds to the already existing choir of reminders as to the threat of terrorism.

If you are installing protective measures in public space, ask yourself: In your city, what do you want the public space to communicate? And then shape the city and the protective measures, if any, accordingly. The Municipality of Copenhagen, for instance, focused on some of the values already associated with the city's public spaces (such as green, inviting and open) and developed protective measures accordingly.

Box: put on your safety glasses

We move around the city where we work every day. Therefore, we can tend to think that we know it inside out, but observing the city more intentionally can bring forth valuable insights and inspiration.

Plan a 1- to 2-hour walk around the city, visiting selected urban spaces that might provide inspiration for your current project. On this walk, imagine that you have on

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a pair of safety glasses (Figure 37) allowing you to look at the city from a new perspective: a safety and security perspective. Are there protective measures you never noticed before? How do they function? What might they communicate to the citizens? How do they interact with / support / obstruct local life?
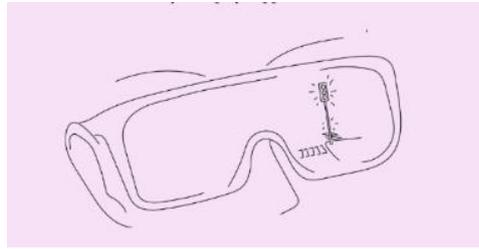

Figure 37: Safety glasses

A. V. Neves: Awareness raising might have contradictory effects. On the one hand, it provides important information on how citizens are supposed to act in case of a terrorist attack and can reduce the consequences of such an attack on the population. In some countries, like the United Kingdom, with higher levels of threat, people are used to following attack scenario drills and awareness-raising campaigns and live well with that reality. On the other hand, the constant warnings about how to proceed in case of an attack might create restless feelings of fear. In places where the terrorism threat is low, the community is not prepared to comprehend the meaning of terrorism risk, and awareness-raising campaigns might be counterproductive, triggering fear instead of preparedness and security. Again, with proportionality in mind, it would not make sense to increase the level of readiness for low levels of threats.

Low social cohesion may increase the perception of incivilities and crime in neighbourhoods. It might indicate space users are not willing to get involved in the protection of the territory making them permeable to threats and dangerous action. There is a relationship between a community's levels of cohesion and the neighbourhood's perceptions of security. There is no space without context nor context without significant action. Within a cohesive social context there are more probabilities to identify suspicious actions and become more aware of threats becoming better prepared to create a level of trust with the police, working together for the common goal.

Although the usual trend is to make decisions based on urban infrastructure needs without considering the impact it might have on citizens' lives (Schindler, 2015, p. 1945), today we know that protecting cities requires apparent softer measures while promoting a healthy environment where fear does not cross people's minds. **Awareness raising is also about involving and informing, on a need-to-know-basis, all relevant stakeholders. Not everyone should know everything, but everyone should be heard** and feel integrated in the process of contributing to the protection of the city. This idea brings people together and increases social cohesion, along with many other activities where institutions work directly with the population, for example, in the rehabilitation of a territory (a plaza, a car park, a segment of a

street, etc.)**.** A detailed discussion on stakeholder involvement is provided in Chapter 5.

Awareness is being raised by the protective measures themselves. Protective measures become symbols. In urban spaces symbols act as cues, signs or hints about the expected behaviour. **Symbols and urban architecture inform people about what is meant to happen there and what is acceptable; in sociological terms, they allow space users in the decoding process of space interpretation.**

Symbols should be clear and fast to understand, as they replace verbal and non-verbal communication. This, however, may be tricky in multicultural cities. Some cultures have different understandings of colours and different interpretation of urban symbols.

In urban settings, the messages of symbols are complemented by other people's behaviours. In a new space, individuals pay more attention to the information received, and look for all signs available to feel oriented, comfortable and in control. General information signage, lighting and other ways to support behaviour can be instrumental for having people more confident at a crowded public space, helping them not only to avoid becoming the victims of common crime, but also in having a better informed reaction in the case of a terrorist event.

Are there differences across Europe in the public's perception of security measures?

S. Ilum: If there is one thing I hope readers working in counterterrorism will take away from this chapter, it is the importance of understanding the context in which they work and how they might go about installing protective measures. Because yes, there are indeed cultural differences between how people perceive public spaces, terrorism and security in different cities around Europe and the world.

How widespread the use of protective measures is differs from place to place. In a country like Denmark, there is very little tradition regarding protective measures in public spaces, and government buildings have always been open to the public. In other countries like England and Ireland, the use of protective measures is much more widespread due to legacies of conflict.

The difference in the history of terrorism and responses to it across various cities may also mean a difference in the sensitivity towards terrorism and protective measures. In the interviews I conducted with both professionals and ordinary citizens in Paris, a city that has for decades experienced terrorist attacks, terrorism was perceived as an almost fundamental part of city life. Meanwhile, in Oslo and Copenhagen terrorism was perceived as a new and shocking phenomenon.

Interestingly, regarding protective measures, city officials in Oslo seemed to be the most accepting and settled with respect to the myriad protective measures throughout the city. In Copenhagen and Paris, however, city officials appeared much more sceptical and worried about the presence of too much security, and in both cities they referred to some of the local city values, ideas about openness and democracy, and how these should not be shaped by terrorism.

In other words, local values, the history of terrorism, city ideals, mediatized images and so forth shape the way people perceive a city and its protective measures. Therefore, I argue for a situated approach that takes local city life into consideration when working with protective measures as well as urban development more generally.

Key take-aways

- Know that there is no one right solution. Working with protective measures requires weighing out different trade-offs and making decisions. Therefore, inform yourself about the topic, make the necessary decisions and be prepared to defend them.
- First, ask yourself: What kind of city do we want? And what do we want our public spaces to communicate? Then plan your protective measures to fit into that framework.
- Understand the local context in which you work:
  o in relation to everyday life: What does it look like? Which lives, perceptions, and routines will the protective measures be part of?
  o in relation to citizens' perceptions of risk and feelings of fear: Where do they feel afraid of terrorism? Which concrete factors evoke such fear? How can we change this?
- Do not add to the already-existing choir of reminders of the threat of terrorism. Communicate as little about (counter)terrorism as possible.

A.V. Neves: Considering that countries have different levels of threats and different levels of readiness to deal with terrorism threats, having a unique solution across Europe to deal with it is not possible. Europe is formed by different cultures, values and behaviours. Terrorism protection solutions require always an integrative and holistic approach which differs from country to country. Perception levels are different, people's reactions are different, and levels of threat are different from place to place and over time.

As mentioned before, one solution does not fit all. Even if solutions might look similar, the process differs from place to place and requires contextualization, integration and adaptation to each reality.

Key take-aways

- Political support is fundamental to protect people, buildings or infrastructures, i.e. from terrorist attacks. Without it is very difficult to set up an effective strategy for that purpose due to lack of funding and clarification about the city's priorities.
- Project managers should integrate complementary knowledge and expertise. It is not possible to concentrate all the expertise in one person.
- Stakeholders are important in protecting their own territory in an inclusive approach. Security depends on everyone, and citizens have an important role to

play in their own protection, emphasising the idea that not all the information should be shared

- Balance is necessary in everything: from informing the community about security measures to developing solutions considering the level of threat. Do not trigger what should be avoided: fear.

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