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European Cities Prone to Terrorist Threats: Phenomenological Analysis of Historical Events towards Risk Matrices and an Early Parameterization of Urban Built Environment Outdoor Areas

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Abstract: Among other risks, contemporary cities are exposed to terrorism. In addition to being sensitive targets, recent events in Europe have underlined the relevance of public open spaces (squares, streets, etc.) as particularly defenseless parts of Urban Built Environments (UBEs). Despite the fact that previous theoretical studies about radicalism have highlighted the "regional" dimension of the threat, the assessment of terroristic risk is still related to American guidelines. This creates new research scenarios for European UBEs and associated Outdoor Areas (UBEOAs). Thus, this paper provides two correlated main goals. The first is the phenomenological analysis of terrorist threats in European UBEs, starting from the events catalogued in the Global Terrorism Database. Specifically, the matrix of risk is assessed by combining (i) the main urban Environmental Classes (ECs) and their sub-classes, referred to as Outdoor Areas (OutECs), and (ii) the Attack Types (ATs) in order to determine the most efficient and recurrent combination of attack methods and targets (AT-EC and AT-OutEC). Then, the paper identifies the parameters influencing the terroristic risk of the most recurrent and efficient attacks identified in European UBEOAs, starting from (i) the analysis of inherent features of the European phenomenon, (ii) previous experiences in the literature and (iii) the permitted strategies and guidelines in European States. The main results are related to the relevance of Armed Assault and Bombing/Explosion Ats and Open Areas with the presence of public and strategic/symbolic buildings (ECs), while an interesting point of discussion is represented by physical obstacles.

Keywords: terrorism risk in Europe; phenomenological risk assessment; parametrization of risk; urban built environment; outdoor areas

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1. Introduction

Terrorism is a phenomenon currently linked to nationalist principles based on extremist ideologies which stem from political or religious divergences. These features are strictly related to the "human" dimension of the threat, making these events difficult to parametrize. As the word itself suggests, violent terrorist acts are planned with the aim of spreading terror, fear and disorientation. Moreover, terrorist violence is connected to two main characteristics [1]: a material function for the generation of "physical" damage in the short term and a "symbolic" one, which supports the concept of terror on a large scale, involving both the "physical" dimension of the Urban Built Environment (UBE) and the "human" one of users.

Even though terrorism is not a phenomenon of modern times, the current meaning is strictly related to the 9/11 attack, which is relevant due to its symbolism, the number of injured persons and the complexity of planning [2]. However, recent events in Europe

have increased the attention paid to this ancient continent, adding the study of such risks to the study of natural threats towards resilient cities [2–5]. At the same time, major studies and applications regarding strategies and methods of assessing terrorism events in cities are related to the USA, where the threat is historically more impactful. European attention toward the phenomenon—after the attacks on Madrid (2004) and London (2005)—has led to the establishment of national regulations, aiming at the analysis and management of threats at the regional scale [6]. Major attention is given to crowded or political, religious, sensitive and public places [7].

The widespread concept of urban resilience to terrorist risk is related to the "Secure by design" practice, which promotes procedures to deter terrorist actions and mitigate damages caused by the attack itself [8]. On the other hand, in the literature, the psychological analysis of human security is also included [9,10]. Procedures for the calculation of risk, as well as related matrixes, still lack applications to terrorism, meaning the theme still has national relevance, and applications to peculiar case studies and guidelines on good behavior are lacking.

In this wider context, this paper discusses the terrorism assessment of Urban Built Environments (UBEs) and the related Outdoor Areas (UBEOAs), as these are particular structures in cities that are exposed to threats but have not been fully discussed in the literature. Specifically, UBEOAs are complex systems of real outdoor areas, buildings, users and infrastructures which interact with each other and are linked to a common frontier: public use in their daily utilization. Moreover, these systems are discussed by focusing on the European continent in order to consider the regional influence of terrorist threats [11], starting with critical events that have already occurred and the experiences that have already been lived through.

With these aims, this study focuses on the phenomenological analysis of terrorist threats based on previous European attacks, highlighting the main features of places and the recurrences of events which influence the threats UBEOAs face; this is carried out for an early parameterization, which would be useful for risk assessment in the most critical conditions derived from the phenomenological analysis of the European phenomenon. Thus, this paper is organized in the following five sections:

- A detailed background of terrorist threats and their relations with UBEOAs (Section 2).
- The identification of tools for the phenomenological analysis of terrorism in European cities and UBEOAs (Section 3).
- The analysis and the discussion of the terrorist phenomenon with a double level of detail (UBE and UBEOAs) for the creation of associated matrixes of risk (Section 4).
- For UBEOAs, an early parametrization of elements involved in the threat. Here, all the elements and features of UBEOAs are involved in the risk assessment according to the risk determinant (Hazard, Vulnerability and Exposure) (Section 5). This is a preliminary reading of UBEs for the future determination of their risk assessment.
- The discussion of the results and conclusions (Section 6).

2. Background of the Relevance of Terrorist Threats and Urban Built Environment Outdoor Areas in Risk Exposure

The inherent complexity in assessing terrorist risk depends on three main points: the definition of the threat, the identification of principles and its multi-disciplinarity.

Major monothematic encyclopedias regarding terrorism reported the absence of a univocal definition of this phenomenon [12,13], highlighting the local "severity" in defining them in national and international regulations. However, three key aspects have to recur simultaneously in a terrorist act [14,15]: (i) the perpetration of violent actions aimed at killing people, (ii) usually, the perpetrator of violence is an individual or is part of an organized group operating and coordinating violence and (iii) the necessity to reach the goal, choosing a symbolic target or a large population. One of the most coherent works in collecting and managing these events is the Global Terrorism Database (GTD)^{TM} [16]. It is the result of interpolation between the research actions, taxonomy and cataloguing activities

of the *National Center for the Study of Terrorism and Responses to Terrorism* (*START*) [16], established at the University of Maryland; it also includes the results of coordination between several authorities and agencies previously involved in attack cataloguing. With these aims, START has introduced its definition of terrorism, functional for the identification of terrorist events, using "characters" and "criteria of cruel act" [17].

Another point of discussion for terrorism is the necessity to comprehend some logical criteria at the basis of the threat. In this sense, major work in "Understanding Terrorism principles" is related to G. Woo [11]. This study has highlighted the presence of some distinctive principles related to the terrorist phenomenon in cities, properly re-elaborated by the authors as four main Terrorism Principles (TPs) and summarized in Table 1.

Table 1. Codification of Terrorism Principles (TP) according to G. Woo [11].

Code/Sub-Code of Terrorism Principle	Description
TP.1	*The Impact Factor* relates the concept of maximizing the terrorist attack
TP.1.1	*Macro-terror*, characterized by the reduction of the frequency due to the complexity of attack planning and execution
TP.1.2	*Micro-terror,* characterized by less management complexity and a high probability of repeatability
TP.2	The "*Publicity Impact is Key to Targeting*" highlights the perpetrator's need to maximize media repercussion
TP.3	*Inter-dependence and replacement of targets* in compliance with the principle according to which "*terrorists will attack the softer of two similarly attractive targets*". This principle can be divided into two macro-categories related to protection systems (TP.3.1 and TP.3.2)
TP.3.1	*Hard targets*, such as government buildings or military headquarters, focus the attention on buildings characterized by a system of active or passive protection technologies, regardless of the probability of occurrence. Professionals and relevant political, religious or media figures belong to this class
TP.3.2	*soft targets*, including subways, pubs, as well as vulnerable sites without any type of defence measure against these phenomena. Considering the human relevance aspect, it is referred to the community, gathered in extensive urban areas, lacking effective protection systems from the terrorist attack
TP.4	*The characterization of terrorist weaponry*, relating to the criterion of minimizing resistance, facilitates the evaluation of the level of threat and the equipment type used by the perpetrator. The same prefers traditional and easily available weapons (guns and explosives)

As the third point of discussion, the multi-disciplinarity of the terrorist threat is discussed in literature with the presence of monothematic and detailed studies focused on: (i) simulations of human behavior and reaction based on agent-based analysis [18–21], (ii) the economic relevance of losses generated by terroristic attacks [22,23] or countermeasures [24,25] specifically applied on critical infrastructures [26–29] or to test the impact of new potential weapons [30], (iii) analysis of some specific Attack Types in combination [31] for specific critical infrastructures. Most of them analyze relevant case studies in which a specific phase of disaster management is discussed or tested after the event (test-specific countermeasures—mitigation phase; understanding the population's reaction—response phase; measuring the effects—recovery phase). However, works discuss specific targets or specific effects, leaving the general dimension of the risk assessment and multi-temporal management of the disaster in urban areas or specific parts.

Today, the relevance of urban spaces and user security for terrorist threat is the content of major national and international normative frameworks, usually determined as guidelines. All the documents aim to manage all the disaster phases—Prevention,

Mitigation and Security—introducing specific rules for the goals. Despite their multiplicity in each area, some specific contact points can be read among them [32]:

- *Active actions* aimed at creating a bi-univocal relation between overarching governances and urban users (e.g., intelligence activities, surveillance).
- *Passive actions* are featured by any feedback from users for the overarching rules that are simply applied (e.g., the normative framework, the design regulations of BE) [10,33]).

In these operative tools, the most relevant focus on the terrorist threat in UBE is connected to the potential high crowd level, maximizing the protection levels during massive events or in representative and significative urban areas. The management of crowded places involves both active and passive actions and, specifically for the latter, most of the attention is on the use of special urban furniture to protect people. Consequentially, the classification of these urban objects and their performances—resistance, materials, codes for tests and efficacy for the Attack Type—follows in the creation of current guidelines (e.g., by FEMA [34]). On the other hand, potentialities in transforming urban aesthetics and user perception of places affect the assessment of mitigative systems in existing places introducing the macro-studies of the "Security by Design" in the UK [35]. Here, the main aim is to ensure multi-disciplinary participation in the transformation process of these places, preserving the inherent value in case of historic relevance [36] as well as avoiding the sense of "insecurity" by users [10].

Despite all the involved strategies and studies previously introduced, recent events in France—Paris 13 November 2015, Nice 14 July 2016-, Germany—Berlin 19 December 2017—and in the UK—London 22 March 2017—demonstrated another level of vulnerability to terrorist threat for outdoor areas in cities during daily use. Here, the relevance of the crowd level is temporally defined by the uses of places or buildings, potentially lower than relevant urban "attractors". It categorizes UBEOAs in daily use as a kind of "*soft targets*" [11], due to a combination of a lack of mitigation systems and their temporal vulnerability to crowding (see TP.3.2, Table 1), as well as the parts of cities with lower resistance, in which the perpetrators may exploit the "*micro-terror*" strategy (see TP.1.2, Table 1).

3. Methods and Tools

It is clear that the political, religious and/or economical relevance of States influence the potential risk exposure [37,38] but this represents a reference parameter when describing and comparing it at the international level. Due to the aims of the work, the risk assessment of terrorism in UBE and UBEOAs requires independence from international relevance, scaling the analysis at the local level. In fact, if political, religious and economical significance at the national level can change for external and independent drivers and requires assessment in the "deradicalization processes", the assessment of terrorist threat on the city scale can support the study of some places in terms of local priority to intervene [39–41]. Instead, the analysis of terrorist threat requires scaling in order to define proper boundary conditions, considering 4 levels of discussion as 4 sub-goals of the work:

G1 Determine the inherent classes of risk for UBEOAs in Europe as a first phenomenological analysis of terrorism based on the assessment of direct comparison with other classes of uses for the UBE.
G2 Understand the relevance of specific uses in UBEOAs that may change the risk classes of such UBE.
G3 Identify the most "efficient" combination of Attack Types and classes of uses in UBEOAs.
G4 Determine the parameters involved in the risk assessment for the most efficient combination identified for UBEOAs.

For the G1, G2 and G3 sub-goals, the analysis requires observing the terroristic phenomenon in Europe, starting from previous traumatic events collected in the Global Ter-

rorism Database (GTD)^{TM} and, specifically, correlating data about the frequency of events and the consequences. Here, the method is supported by the creation of matrices of risk levels. Specifically, matrices of risk result from the frequentist probability (P_F), as outcomes of observing events (ratio between n. of event type and total number of events), and Consequence (C), assessed as the sum of injured persons and victims. Specifically, matrices combine levels of likelihoods and consequences as specific ranges of P_F and C, as a more comprehensive way to categorize the couples of Environmental Classes of uses for UBE and UBEOAs and Attack Types. This is in line with the a posteriori analysis of the phenomenon, usually used for the risk assessment [42,43], and the data collected in the GTD which focus on the population damage. This excludes the possibility to consider effects on buildings, which result from only a few types of attacks (e.g., damage from bombs and car bombs, while cold steel is excluded).

The second level of analysis (G4) is related to the risk assessment procedure, involved in the quantification of the risk class for real cases in possible future scenarios. However, due to the goal, the analysis cannot provide the formulation of the risk, but it aims to study the parameters affecting three main Determinant of Risk in UBEOAs: Degree of Hazard (H)—strictly related to the phenomenological analysis; the Vulnerability (V)—the inherent capacity of the system elements to suffer damage; and the Exposure (E)—the level of potential damages or consequences. It is the most used approach for the assessment of thematic and detailed relevance in Natural Disaster Risk Reduction supported by the UNSDRR [44,45].

As far as our four goals are concerned, the present work pursues a double-phase methodology, starting from the lack of literature analyzing urban outdoor areas exposed to terrorist threat and using traditional tools to assess the risk. Moreover, the analysis is BE centered, overlooking the psychological and economical relevance of effects, and it considers the relation between UBE and UBEOAs and their effects on users.

Figure 1 shows the applied phases, highlighting starting data (state-of-the-art), processing data relations and outputs.

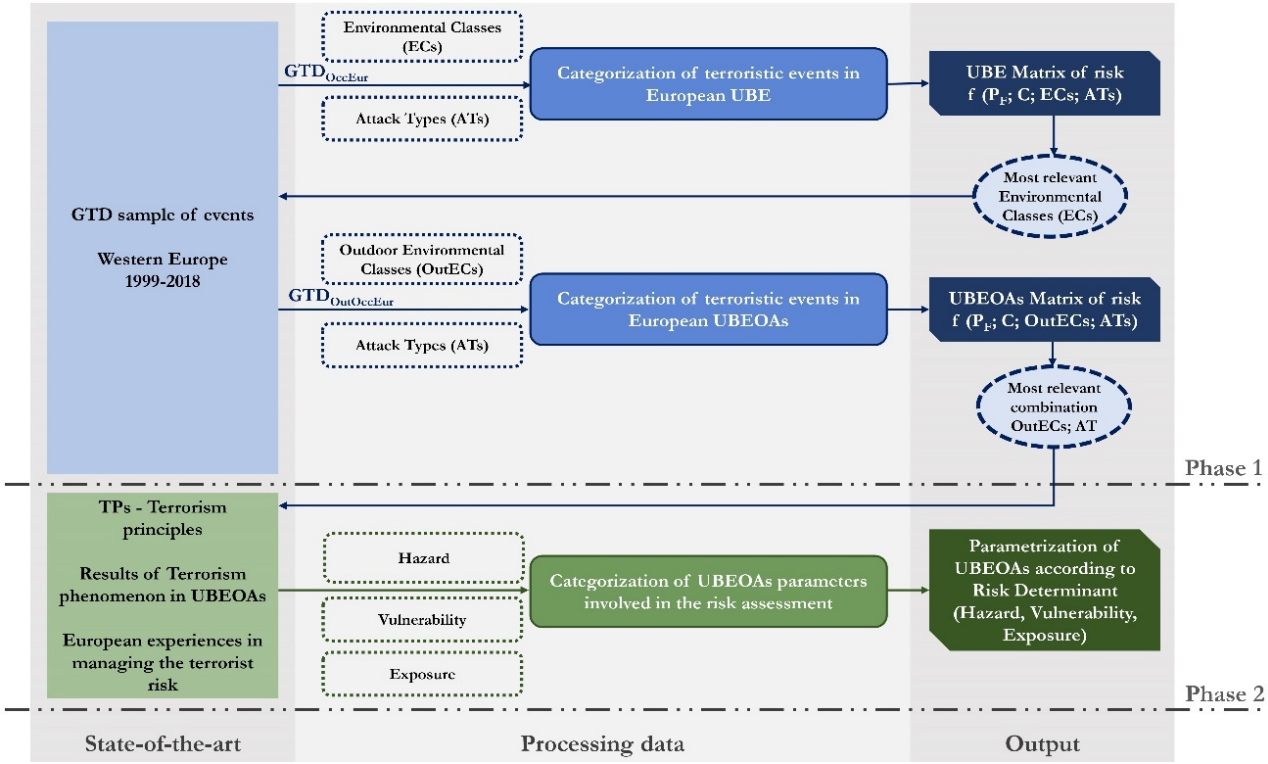

Figure 1. Flow of the applied method, separating the starting data, the processing of collected data and correlated outputs.

Specifically:

Ph.1. The determination of risk matrices related to terrorist threat results from the study of the events catalogued in the GTD in the western Europe UBE and UBEOAs. Here, the phenomenological analysis follows a double level: firstly (Section 4.1) (i) the categorization of the events in European UBE, which occurred 1999–2018 (GTD_{OccEur}), according to Environmental Classes (ECs), as recurrent UBE for uses and types, and Attack Types (ATs) and (ii) the qualification of events according to the frequencies and consequences of each ECs-ATs combination. This highlights the most relevant ECs exposed to the events. The second level of analysis (Section 4.2) considers the same procedure for the reduced GTD sample, where only attacks occurring outside the most relevant ECs (UBEOAs) are considered ($GTD_{OccEurOut}$). Thus, the selected events are studied in order to (i) categorize the events in the reduced sample, as couples of selected Outdoor Environmental Classes (OutECs) and Attack Types (ATs) and (ii) to qualify the matrix of risk according to the frequencies and consequences of each OutECs-ATs combination. Both levels are functional in identifying two risk matrixes for the rapid assessment of the Terroristic Risk Levels in Europe and the most exposed UBEOAs, as a direct combination of AT and ECs/OutECs (Section 4.3).

Ph.2. The parameterization of elements influencing the Determinant of Risk (Vulnerability, Hazard and Exposure) in the most hazardous risk classes (OutdoorEC; AT). In this phase, the main national and European instruments used to manage the terrorist threat are analyzed to highlight which morpho-constitutive elements influence the risk, mainly organized in a short index of representativeness (Section 5). Here, the process combines the results of the phenomenological analysis on UBEOAs (Section 4.3), the European experiences in managing terrorist threat and the principles of the phenomenon (TPs), previously identified in Table 1.

4. The Phenomenological Analysis of Terrorism in Urban Built Environment Outdoor Areas in Western Europe

4.1. Categorization of Terrorist Events in European Urban Built Environment

The qualitative assessment of terrorism is based on the Occidental European events registered in the GTD during the last 20 years (1999–2018), close to the most traumatic attack. Temporal and geographical selector parameters are derived from the comprehensive reading of terrorism principles.

The GTD_{OccEur} refers to all the UBE, and it counts 1781 events; the sample considers the total amount of events reduced considering the aborted ones (860) and the attack referred to specific targets as relevant people (1091). This is possible thanks to the classification of events by the specific database variable "Target/Victim information" (section vi, [17]). Thus, the sample has been parametrized according to two main relevant characteristics:

1. The Attack Types (ATs), following the classification process of GTD as "weapon information", recoding them with the Tn code.
2. The Environmental Classes (ECs), using a process of recoding the "Target/Victim information" variable (section vi, [17]). In this case, six Environmental Classes (defined with a Capital letter) are introduced for the parametrization of targets, considering the potential crowd levels (*impact Factor criteria*), the political/religious meaningfulness of urban spaces (*Publicity impact Criteria*), the existing security and checking systems (*impact factor on micro/macro terror*) and the Built Environment typology (*Outdoor area/building*).

Table 2 reports the codification of ECs and ATs according to the parametrization of the sample. Specific classification of ECs and the relative GTD environmental one is reported in Appendix A. The identification of major features describing the Environmental Classes and the Attack Types is functional in discretizing the phenomenon according to the goal of this phase. Here, the terrorist threat at the European scale is analyzed, highlighting the combination of relevance in terms of Environmental Classes (ECs), Attack Types (ATs) and the number of fatalities and injured people, as reported in the GTD (section viii, [17]).

Table 2. Codification of Environmental Classes [X] for terrorist attack targets and Attack Types [Tn].

Environmental Classes (ECs)		Attack Types (Tn)	
Code	**Built Environmental Typologies**	**Code**	**Description**
[A]	Airport, docks, metro and rail stations	[T1]	Assassination
[B]	Theatres, museums, bars, restaurants, hotels, shopping centers, churches	[T2]	Armed Assault
[C]	Hospitals, schools, universities	[T3]	Bombing/Explosion
[D]	Representative (symbolic) or strategic buildings	[T4]	Hijacking
[E]	Residential buildings and industries	[T5]	Barricade Incident
[F]	Open areas, squares and streets	[T6]	Kidnapping
		[T7]	Facility/Infrastructure Attack
		[T8]	Unarmed Assault

Starting from the sample GTD_{OccEur}, the evaluation of frequencies stems from the analysis of the ATs combined with ECs, pointing out the relevance of the latter in terms of attack number for each AT; this generates 48 combinations. Figure 2 summarizes the results, remarking on the lower relevance of the C (Hospital, schools, universities) class in all the combinations, while B (Theatres, museum, bar), D (Representative/strategic buildings), E (Residential buildings and industries) and F (Outdoor areas) classes represent the most frequent ones, in combination with T2 and T3 ATs (Figure 2).

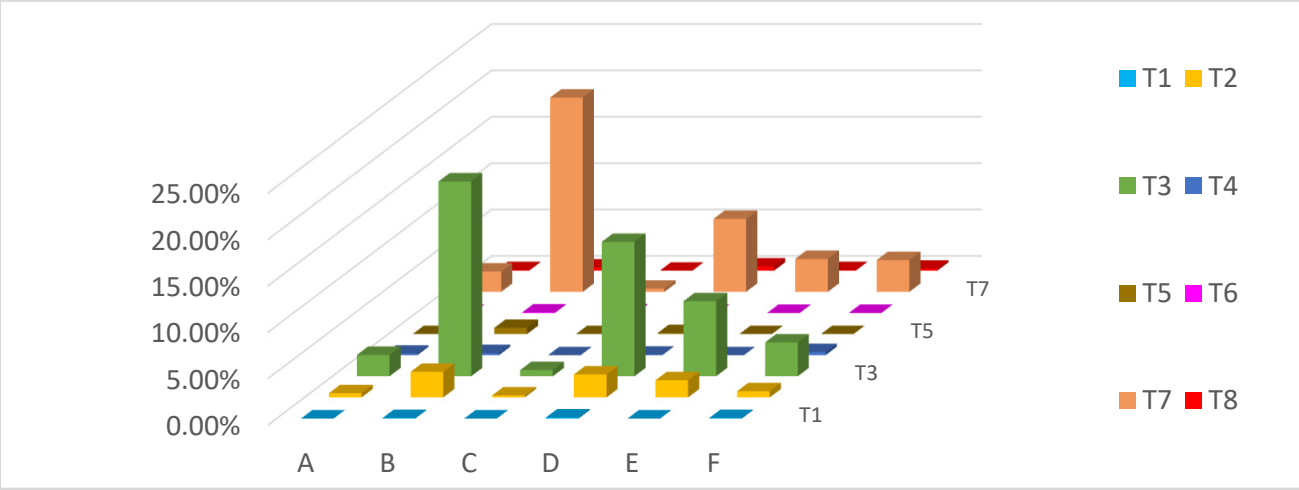

Figure 2. Percentages of frequency related to Attack Types (T1–T8) and ECs (A–F) related to the number of traumatic events (1781).

For each combination, associated values of frequentist probability (P_F) are associated with five classes of Likelihood (Very Likely, Likely, Possible, Unlikely, Remote), relating P_F values in the entire period, as shown in Table 3. Levels are defined in ranges related to absolute temporal variation. Analyzing the sample, for 1781 events in 7300 days (20 years) a mean frequency of one event every 4 days can be related. So, the scale of one event per week represents the main value; thus, classes follow the daily, weekly, monthly or yearly frequency of events (Table 3) for each combination of AT and ECs. Thus, P_F values are related to the created likelihood levels.

Table 3. Likelihood levels for the terrorist risk assessment in Europe, associated with Frequentist Probability (P_F) evaluated in all the period (7300 days) (x).

Score	Likelihood Levels		Description
5	Very likely	$x > 50\%$	Until 1 event per day
4	Likely	$14.25\% < x \leq 50\%$	Until 1 event per 2 days
3	Possible	$3.3\% < x \leq 14.25\%$	Until 1 event per week
2	Unlikely	$0.3\% < x \leq 3.3\%$	Until 1 event per month
1	Remote	$x \leq 0.3\%$	Until 1 event per year

All the P_F values are related to the Likelihood Levels (Table 3) in the specific correlation matrix (Table 4) for each EC/AT combination. It is useful to transform the remarks on frequencies from a relative analysis (D/T2 frequency is higher than E/T2)—detailed according to the number of events—to an absolute one according to the ranges defined for the Likelihood levels (D/T2 and E/T2 have the same likelihood levels). In detail, the correlation matrix in Table 4 highlights the "Possible" likelihood level for Bombing/Explosion (T3) Attack Types in B and D classes, as well as for the infrastructural attack (T7) for the B class.

Table 4. Correlation Matrix for the Likelihood levels of Atsth–ECs combinations.

Attack Type/ Environmental Class	A	B	C	D	E	F
T1	Remote	Remote	Remote	Remote	Remote	Remote
T2	Remote	Unlikely	Remote	Unlikely	Unlikely	Remote
T3	Unlikely	Possible	Remote	Possible	Unlikely	Unlikely
T4	Remote	Remote	Remote	Remote	Remote	Remote
T5	Remote	Remote	Remote	Remote	Remote	Remote
T6	Remote	Remote	Remote	Remote	Remote	Remote
T7	Unlikely	Possible	Remote	Unlikely	Unlikely	Unlikely
T8	Remote	Remote	Remote	Remote	Remote	Remote

Concerning the recurrent ATs, T2, T3 and T7 result the most frequent attack typologies in the total cases, too; this is in line with their distribution during all the considered periods. T2, T3, and T7 have medium values for frequencies for all the years equal to 12%, 57% and 25%, respectively, with a few exceptions.

As the second step in studying the phenomenon, the analysis evaluates the consequences in terms of Fatalities (F) and Injured persons (I). Moreover, it aims at identifying the most traumatic AT(s) combined with the minor resistant level(s) of ECs.

Figure 3 reports the percentage of Fatalities (F) and Injured (I) persons evaluated for each EC and AT in the 1781 events registered in the GTD_{OccEur} sample. Major consequences are observed in T2 and T3 ATs, especially involving A-B-D-F classes. Moreover, B class is also involved in T5 (Barricade Incident) as a singularity. So, if B and D classes represent the most ECs for the attack, A, B, D and F combined with T2 e T3 ATs represent the most "efficient" terroristic attack. The higher effect registered in the A class is related to the crowd that affects airports, metros and rail stations. The F (outdoor areas) class follows the same remarks in a reduced way.

The consequence levels are determined following a 5-scale classification, as seen for the Likelihood. Here, the levels describe Extreme, Major, Medium, Moderate and Minor consequences (Table 5) using the main values (similar to Likelihood). In fact, considering the entire sample, every attack involves three people (counting both victims and injured people, we had a total of 5445 people). So, the ranges vary considering classes of 3×10^n correlating to $3 \times 10^1 = 3$ the medium impact, assessed as the number of people involved during each combination. For all the combinations EC-AT, Table 6 reports the correlation matrix between the "Consequence levels" and impacts assessed for all the combinations. As in the Likelihood discussion, the use of the correlation matrix solves the absolute

assessment of the impact, highlighting the higher relevance for the combinations A/T3, B/T3, F/T2 and B/T5 (Extreme). Moreover, T2 and T3 represent the most relevant AT for any EC, while B, D and F constitute the ECs featured by higher levels of consequences for more ATs.

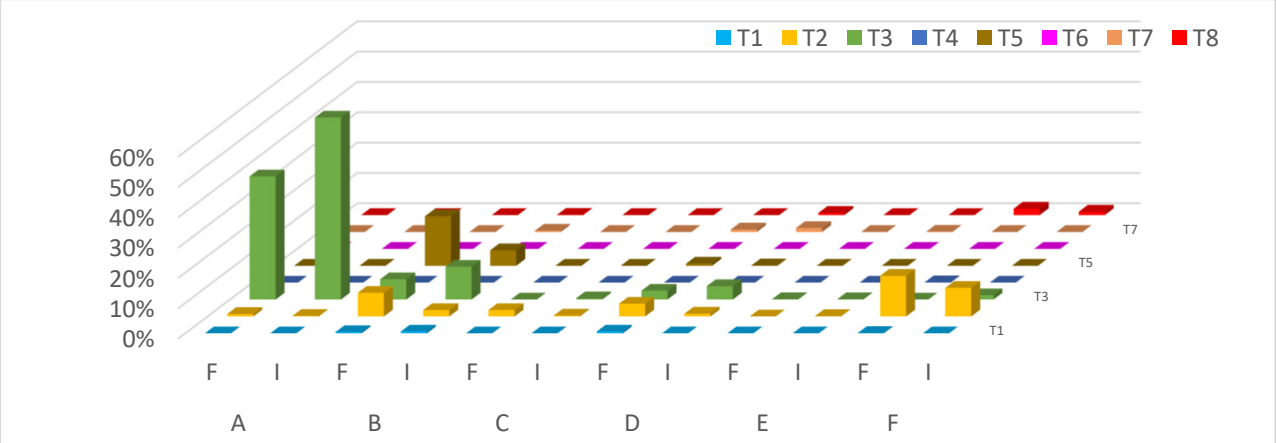

Figure 3. Percentages of impact related to ATs and ECs, considering Fatalities (F) and Injured (I) for each ECs.

Table 5. Classes of Consequence levels.

Score	Consequence Levels	
5	Extreme (Ex)	$x > 3 \times 10^3$
4	Major (Ma)	$3 \times 10^2 < x < 3 \times 10^3$
3	Medium (Me)	$3 \times 10^1 < x < 3 \times 10^2$
2	Moderate (Mo)	$0 < x \leq 3 \times 10^1$
1	Minor (Mi)	$x = 0$

Table 6. Correlation Matrix for the Consequence levels related to ATs–ECs combinations.

Attack Types/ Environmental Classes	A	B	C	D	E	F
T1	Mi	Ma	Mi	Me	Mi	Mo
T2	Me	Ma	Me	Ma	Me	Ex
T3	Ex	Ex	Me	Ma	Me	Ma
T4	Mi	Mi	Mi	Mi	Mi	Mo
T5	Mi	Ex	Mi	Me	Mi	Mi
T6	Mi	Mi	Mi	Mi	Mi	Mi
T7	Mi	Me	Mi	Ma	Me	Mi
T8	Mi	Me	Mi	Ma	Mi	Ma

4.2. Categorization of Terroristic Events in European Urban Built Environment Outdoor Areas

As a result of the remarks highlighted in the previous section, the analysis of terrorist threat in UBEOAs requires the improvement of cases. The F class is not purely representative of such a BE type (considered as the Attack targets). According to the widest concept of urban outdoor areas, squares and streets are usually the result of a combination with buildings; their relevance in considering the terrorist threat also depends on the fact that people may also prefer to stay outside such buildings for a long time. Li Piani [46], with the introduction of the Space of Influence (SoI) in assessing emergency plans for terrorism attacks, underlined the real interaction of "external areas" of buildings and the pure concept of "outdoor areas" as defined in the F class for the GTD variable. In fact, as in the case of Bataclan, several attacks are classified in B or D classes, but start or partially occur outside the relative buildings. The GTD allows the identification of targets according

to their class, but it includes all the information related to the event, as the exact location, as a description in the "comment" line of each registered event. The necessity of studying the sample reducing the cases to external attacks moved the author to apply this search process. However, only B and D classes are included in this section due to their relevance, which was highlighted in the previous section.

The GTD_{OccEur} sample was checked for B and D classes. Here, all the words related to outdoor areas ("street", "square", "sidewalks", "entrance") or pertinent adjectives ("out", "outside", "outer", etc.) are searched in the "comment" cell, where the attack descriptions are included. The checked sample counts about 50% of attacks in D and B classes. So, the reduced sample $GTD_{OutOccEur}$ comprises all the cases related to F class and outer areas of B and D classes. The latter, indicated with F_B and F_D, respectively, constitute the Outdoor Environmental Classes (OutECs). The reduced sample counts 787 terrorist attacks in the same period and involved 1218 injured persons and 258 victims.

Following the application on previous sample, Figure 4 shows the distribution of OutECs and ATs in the analyzed sample. As far as the absolute assessment of frequencies is concerned, the same 5-scale classification of Likelihood levels (Table 3) is used to define a customized profile on OutECs and ATs, summarized in the Correlation matrix in Table 7. Here, T2, T3 and T7 Attack Types represent the most frequent AT in the whole sample, decreasing the Likelihood levels.

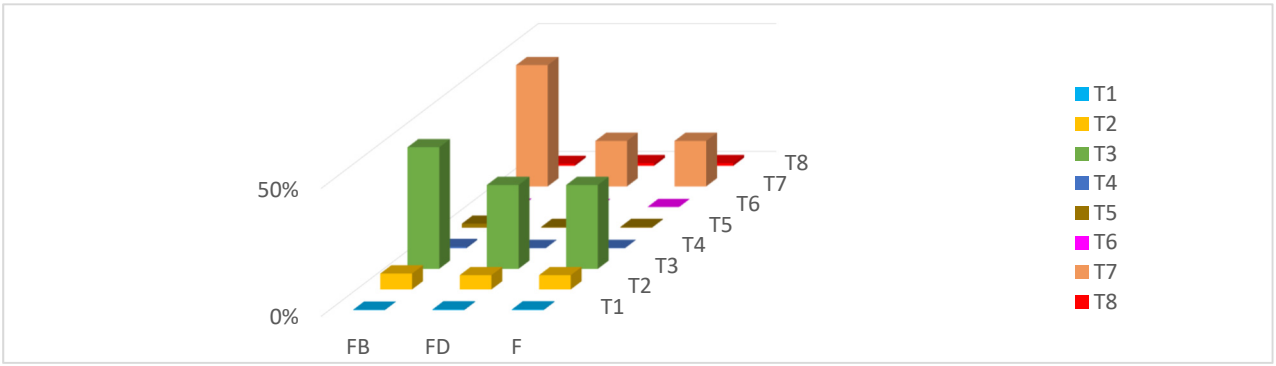

Figure 4. Percentages of frequency related to Attack Types (T1–T8) and OutECs (F; F_B, F_D) related to the number of traumatic events (787).

Table 7. Correlation Matrix for the Likelihood levels of ATs—OutECs combinations.

Attack Type/ Environmental Class	F_B	F_D	F
T1	Remote	Remote	Remote
T2	Unlikely	Unlikely	Unlikely
T3	Unlikely	Unlikely	Unlikely
T4	Remote	Remote	Remote
T5	Remote	Remote	Remote
T6	Remote	Remote	Remote
T7	Unlikely	Unlikely	Unlikely
T8	Remote	Remote	Remote

Applying a similar approach, Figure 5 summarizes the results of the assessment for consequences, summing the injured people and fatalities. According to the previous phase of analysis, the higher level of exposure for F and F_B is confirmed, and T2 and T3 are identified as the most efficient Attack Types.

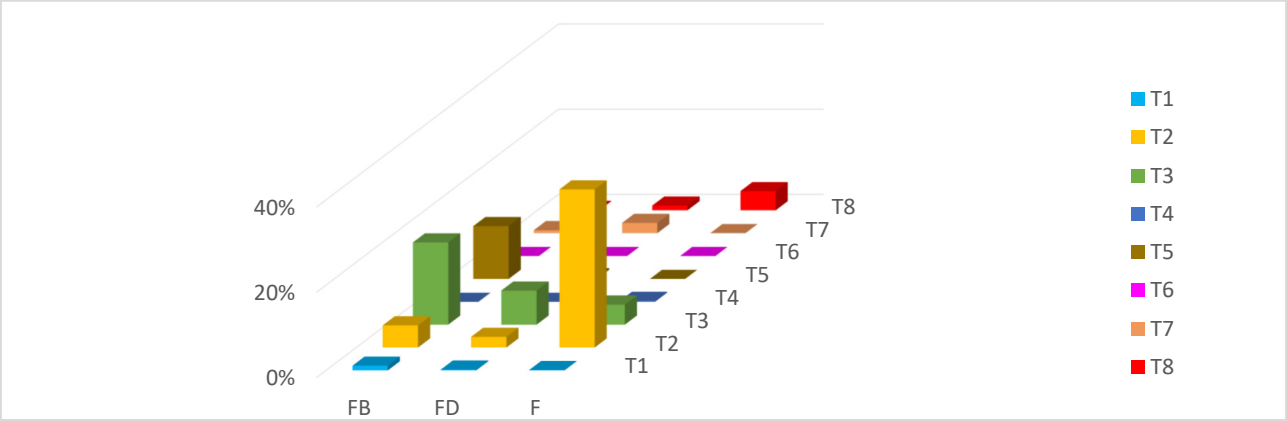

Figure 5. Percentages of consequences related to ATs and OutECs.

The resolution of impacts in all the analyzed combinations of OutECs and ATs are summarized in the correlation matrix shown in Table 8, analyzing the impacts according to the previous Consequence levels in Table 5. Unlike the previous case, the reduced sample have highlighted less T7 attacks in similar ECs; this may be explained by considering the perpetrator's inclination to use such an Attack Type for inner spaces.

Table 8. Correlation Matrix for the Consequence levels related to ATs—OutECs combinations.

Attack Type/ Environmental Class	F_B	F_D	F
T1	Me	Me	Mo
T2	Ma	Ma	Ex
T3	Ma	Ma	Ma
T4	Mi	Mi	Me
T5	Ma	Me	Mi
T6	Mi	Mi	Mi
T7	Me	Me	Mi
T8	Mo	Me	Ma

4.3. Results on the Phenomenological Analysis of Terrorist Threat in Western Europe—The Matrixes of Risk for the Built Environment and Related Outdoor Areas

According to the main goals of the phenomenological analysis, this section summarizes the results for the Terroristic Threat in the Built Environment (GTD_{OccEur}) and the most vulnerable Outdoor Areas ($GTD_{OccEurOut}$) in Western Europe by means of risk matrices, aiming for qualitative and fast assessment. The matrix of Risk is defined as the product of Likelihood and Consequence levels, for which a score of 1–5 is associated in ascending order for each level (from 1 = Minor to 5 = Extreme and from 1 = Remote to 5 = Very likely for Likelihood and Consequence levels, respectively). Combining scores, the risk assessment varies between 1 and 25 according to four risk levels, as defined in Table 9.

Table 9. Classes of possible risk Levels for Terrorism assessment in Europe.

Risk Levels	
Very high	$15 < R_1 < 25$
High	$8 < R_2 < 14$
Medium	$4 < R_3 < 7$
Low	$1 < R_4 < 3$

Following Tables 10 and 11 report the Matrixes of Terrorist risk, as discussed.

Table 10. Matrix of risk for Terrorism assessment in Europe.

		Consequence Levels												
		Minor		**Moderate**		**Medium**			**Major**			**Extreme**		
		Low							Medium					
Likelihood Levels	Remote	All the others		F/T1	F/T4	D/T1 C/T3	A/T2 D/T5	C/T2 B/T8	B/T1 D/T7	D/T2 D/T8	D/T3 F/T8	F/T2	B/T5	1
	Unlikely	A/T7	F/T7			E/T2	E/T3	E/T7	B/T2	F/T3		A/T3		2
	Possible	B/T7		B/T3	D/T3	B/T7						B/T3		3
	Likely													4
	Very likely													5
		Medium		High		Very High								
		1		2		3			4			5		

Table 11. Matrix of risk for Terrorism assessment in European UBEOAs.

		Consequence Levels												
		Minor		**Moderate**		**Medium**			**Major**			**Extreme**		
		Low							Medium					
Likelihood Levels	Remote	All the others		F_B/T8		F/T4 F_D/T8 F_D/T5		F_B/T1 F_D/T1	F/T8		F_B/T5			1
	Unlikely	F/T7	F/T1			F_B/T7		F_D/T7	F_B/T2 F_B/T3 F/T3		F_D/T2 F_D/T3	F/T2		2
	Possible													3
	Likely													4
	Very likely													5
		Medium		High		Very high								
		1		2		3			4			5		

Specifically for the Matrix of risk for Terrorism assessment in Europe for the Built Environment (Table 10), some remarks can be highlighted:

- Outdoor areas (F class) are featured by low-risk exposure both for T2 (Armed Assault) and T3 (Bombing/Explosion) Attack Types. However, T2 relevance depends on the high probability of the attack occurring, while T3 relates to the higher impact of consequences. The case in Barcelona (Ramblas) on 17 August 2017 is the most representative case of F/T2 combination in Western Europe.
- Environmental B Class represents the most exposed one. Both T2 and T3 risk levels are higher than outdoor areas (F) emphasizing high likelihood and consequence levels, respectively. B class includes all the public buildings (pubs, museums, etc.) in which human activities related to amusement take place, and which are usually featured by low levels of control. In B/T2 combination, the peculiar case is the Bataclan Attack that occurred in Paris on 13 November 2015.
- Moreover, the D class (representative or strategic buildings) represents a medium combination. Focusing on the D-T3 combination, it is representative that all the attacks by trucks or cars aimed at acquiring a symbolic or strategic meaning; however, according to the relevance highlighted in consequences and likelihood, it appears relevant for the real position of events that usually are linked to the external area of buildings.
- Finally, the A class—including airports and rail stations—is the most exposed class due to its high probability for the presence of crowds. However, the relevant security

system moves the A class in the Macro-terror classes of attacks, in line with actual processes of security management for these places.

Concerning the Matrix of Terrorist risk assessment for European UBEOAs (Table 11), major results refer to the relevance of 3 OutECs combined with two ATs. Specifically, T2 and T3 move all the combinations in high (F_B/T2, F_D/T2, F_B/T3, F_D/T3, F/T3) and very high (F/T2) risk levels. However, their risk relevance derives from the higher Consequence levels as a direct result of their inherent odds of crowding.

At the end of the qualification of the $GTD_{OutOccEur}$, some major results can be summarized, creating an association with the first level of inherent features of the analyzed UBEOAs and the principles of terrorism (see Table 1):

- All the UBEOAs included in F and F_B are more exposed than F_D (strategic and symbolic ones) due to their different "protection and security systems", moving perpetrators through the first two as a minor resistant line (TP.3).
- The relevance of T7 in strategic and symbolic areas reflects the symbolic relevance of $F_{D,}$ where the attack aims at the milieu (TP.2).
- From a wider perspective, as the most frequent attacks, T2 and T3 reflect the principle that describes the choice of weapon (TP.4).
- UBEOAs are prone to terrorist attacks due to the high probability of crowding (TP.3—soft targets).
- T2 and T3 represent the most used Attack Types (TP.1—micro-terror) and they generate the highest levels of impact.
- The maximization of impact is highlighted for the F_B class. Differently from F_D featured by a higher level of openness—inherent to the necessity to guarantee visibility—the presence of obstacles in F_B can reduce the capacity of escape (TP.3—soft targets).

5. The Parametrization of Elements in Urban Built Environment Outdoor Areas Influencing Vulnerability, Hazard and Exposure in the MOST Hazardous Risk Classes

The identification of ATs—ECs combinations featured by higher levels of Likelihood and/or Consequences helps in recognizing inherent features of the Built Environment prone to Terrorism. Moreover, previous analysis highlights the relevance of UBEOAs and the system of external areas of buildings in assessing the risk exposure of such Built Environment classes.

In this section, the assessment of risk reconsiders both the inherent responsibility of OutECs and ATs and the geometric and security features of Outdoor BE, recognized as influential in previous European experiences. In detail, all the parameters result from the systematic analysis of (A1) Terrorism principles (TP in Table 1), (A2) inherent environmental results of the terrorism phenomenon in UBEOAs (Section 4) and (A3) European experiences in Europe in managing the terrorist risk. The latter results from the national regulation analysis of major European States provided with the structured legal framework, such as France, Germany, the United Kingdom, Belgium, Sweden and the Czech Republic (see Table 12).

In detail, after reading these elements, specific keywords are identified and checked in order to determine their reliability, with specific parameters or features related to the real UBEOAs. Here, these keywords are then associated with physical elements of the built environment and their relations with the place. Specifically, features or parameters are associated with elements or properties that could be located within the frontier or/and inside of UBEOAs. Finally, keywords are associated with the Risk Determinant according to the widespread definitions introduced in [47]:

- "hazard" usually refers to "the possible, future occurrence of natural or human-induced physical events that may have adverse effects on vulnerable and exposed elements". If the feature of the "return period" is usually associated with natural events, for terrorism risk, it is necessary to focus on the capacity of the perpetrator to be "attracted" toward the analyzed places and "moved" by specific motivations.

- "vulnerability" refers to "the propensity of exposed elements such as human beings, their livelihoods, and assets to suffer adverse effects when impacted by hazard events". Due to these features, vulnerability to terrorism of places should consider all the elements of UBEOAs that can support or represent specific weaknesses.
- "exposure" is related to the "impact" concept. IPCC suggests that exposure refers to "the inventory of elements in an area in which hazard events may occur". In the case of the terrorist threat, exposure refers to human security, correlating with specific features or elements that could increase the number of people involved in the events, or the maximization of victims.

Thus, starting from the critical and expert analysis of the selected works and results discussed in previous sections, nine keywords are identified for the qualification of the terrorist risk, properly analyzed in the documents: "TARGET", "USES", "PREVENTION", "FORM/SHAPE", "ACCESSIBILITY", "OBSTACLES", "ATTACK TYPE", "CROWD", "REACTION/OBSTACLE". All these keywords are examined in order to highlight the correlation between the risk determinant, the relation to physical elements or inherent features of UBEOAs and to highlight if physical elements are arranged alongside and/or in the frontier of UBEOAs.

By focusing on the data collected in Table 12, all the Keywords are re-elaborated in terms of "indexes" to support the parametrization process. The discussion of details follows, starting from Hazard indexes identified for Target, Use and Prevention recurrent keywords:

- [H_I.1] Index of targets (i_{TRG}): each ECs has an inherent probability to be attacked, as demonstrated in previous sections (in terms of relevance in likelihood for B and D classes of ECs and consequently for F_B, F_D and F OutECs) (T2—Section 4). Here, the "environmental" relevance of the place depends on the inherent likelihood to be attacked, as a consequence of "Soft Target" significance (TP.3.2). The dimension of the target cannot exclude the symbolic relevance of Outdoor Areas. In fact, even if the previous assessment of the terrorist phenomenon follows a geographic independent analysis, the choice of Outdoor Areas should be related to the religious, political and economic relevance (e.g., Navigli in Milan, Ramblas in Barcelona). For them, the concept derives from the "*Inter-dependence and replacement of targets*" as included in TP.3 for the case of "soft targets", while the presence of representative and symbolic buildings included in B or D ECs can influence the "Publicity impact" (TP.2).
- [H_I.2] Index for uses of BE (i_{USE}): according to the necessity to "maximise" the effect of violent acts, the use of Outdoor Areas and their buildings likely has different relevance (TP.1). It is also in line with the results of the assessment of the phenomenon according to which the high level of crowding affects the "attractiveness" of places for the choice of place by perpetrators (T2—Section 4) [48]. As a close dependent property of the previous index, the representativeness of a place, also for the presence of cultural and historical sites, highlighted how the "cultural" or "touristic" use of places may influence the total amount of people in a place [49]. In this sense, the index of use reflects the variety of crowding levels in Outdoor Areas as a consequence of touristic fluxes and consequent specific activities and, thus, should be date/time dependent.
- [H_I.3] Index of prevention (i_{PREV}): according to the current significance of terrorism in cities, the high level of countermeasures or mitigative solutions can influence the potential likelihood of the threat for Outdoor Areas; this is because of the difference between hard and soft targets (TP3). Similarly, the protection systems could vary in terms of weaponry—the Attack Type—used to reach the violent goal (TP4). In this case, the index describes both the presence of preventative solutions in the urban BE (e.g., access control, heavy barriers) and the capacity to be efficient in the specific Attack Type (e.g., vehicles or cold steel) [48–52]. Here, all urban physical elements defined as mitigative, as well as geometric features of accesses, could be included in the assessment [32]. Due to that, in this index, we included all the physical elements included in the Outdoor Areas, as well as along the frontier.

Table 12. Matrix of recurrent keywords analyzed in T1, T2 and T3 themes, summarized for specific contents, references, risk determinant and relation to the BE as physical element and its possible position in the UBEOAs.

Keyword	Theme	Code	Contents	Reference/Section	Risk Determinant	Physical Element of BE	Position or Association of Element/Feature in BE—F (Frontier)/I (Inside)
TARGET	T1	TP.3; TP.3.2	Inter-dependence and replacement of targets; soft target	[11]	H		
	T1	TP.2	Publicity impact is key to targeting	[11]	H		
	T2		Each EC has an inherent probability to be a target due to the relevance to be a soft target	Section 4	H		
	T3		Symbolic value of the target; presence of media	Section 4	H		F/I
USES	T1	TP.1	Impact factor	[11]	H		
	T2		The potential high level of crowd of EC increases the likelihood of hazard	Section 4	H		F/I
	T3		People gathered in one place	[48]	H		
	T3		The level of alert could consider the attraction of places for tourists that can increase crowding	[49]	H		
PREVENTION	T1	TP.3.1	Hard target	[11]	H		
	T2	TP.4	The characterization of terrorist weaponry	Section 4	H		
	T3		Security personnel, the presence of the police force	[48]	H	X	F/I
	T3		The introduction of countermeasures can prevent the access of vehicles	[50,51]	H	X	F/I
	T3		Study strategies for controlling accesses	[49,52]	H		F

Table 12. *Cont.*

Keyword	Theme	Code	Contents	Reference/Section	Risk Determinant	Physical Element of BE	Position or Association of Element/Feature in BE—F (Frontier)/I (Inside)
FORM/SHAPE	T3		The presence of speed regulation elements limits the speed of vehicles along the street	[50,51]	V		F
ACCESSIBILITY	T3		The local topography of the place can preclude the vehicle-borne threats	[53]	V		F/I
	T3		Mitigative measures should be correctly designed to be effective	[51]	V		F/I
	T3		Management of the vehicular traffic	[52,54]	V		F
OBSTACLES	T1	TP.3.2	Soft target, not only as a place but also as a part of the place that allows high crowd levels (i.e., archaeological sites, stairs)	[11]	V		I
	T2		Most of the "attractor" classes also have a high crowd level outside the buildings (F_D-F_B) (i.e., Dehors)	Section 4	V	X	F/I
	T3		The presence of mobile of fixed obstacles as specific attractors for people (rendezvous, hangouts)	[52]	V	X	F/I
ATTACK TYPE	T2		Inherent capacity of attack to maximize the effects	Section 4	E		F/I
	T3		Study different strategies relating possible Attack Types	[49,52]	E		F/I
CROWD	T1	TP.1	The impact factor	[11]	E		F/I
	T2		The high level of crowding in some ECs influences the total number of victims	Section 4	E		F/I
	T3		Check the variability of density in some part of the places	[52]	E		F/I

Table 12. *Cont.*

Keyword	Theme	Code	Contents	Reference/Section	Risk Determinant	Physical Element of BE	Position or Association of Element/Feature in BE—F (Frontier)/I (Inside)
REACTION/OBSTACLE	T3		Use urban furniture or urban object as protection during the attack	[55–57]	E	X	F/I
	T3		Check the access and emergency paths and their capacity to be crossed during the evacuation	[52,56,57]	E	X	F/I
	T3		Check for the presence of obstacles in the access points	[54]	E	X	F
	T2		All the protective obstacles should be analyzed in terms of efficacy for each Attack Type	Section 4	E	X	F/I

In addition, for Vulnerability, three indexes are identified and described according to the data summarized in Table 12:

- [V_I.1] The form of spaces (i_{SHP}), referring to the plan and geometric features of Outdoor Areas, as well as its morphological structure. In detail, focusing on two main shapes of spaces, compact or elongated shapes can influence the Attack Type effect. In fact, an armed assault has major effectiveness for compact shapes compared to elongated ones; on the contrary, an elongated space facilitates the attack by vehicles, because of the direct relation between acceleration and space [51,53]. Similar relations can be associated in the case of bombing attacks, considering car bombs parked or bomb packages. This index should consider the geometrical features of Outdoor Areas, as well as external areas of specific attractors (e.g., for the presence of ramps outside buildings), that may influence the vulnerability of the place.
- [V_I.2] The accessibility level of the urban outdoor area (i_{ACC}): the descriptor considers both physical and conditioning features along the perimeters of Outdoor Areas, mainly focusing on access. In fact, an Outdoor Areas featured by a very high permeability level (e.g., fragmented built frontier for the presence of several streets coming in the Outdoor Areas) both for people and vehicles increase a place's average vulnerability to attacks [51]. In this sense, the characterization of accesses for this index should be related to the geometric features, as well as to the management of accesses [52,54]. Considering the accesses as a physical part of Outdoor Areas, main features to consider include the width of accesses, the presence of specific urban furniture that reduces the width, or the local topographic features of the accesses that influence the accessibility (i.e., stairs) [53]. The traffic limitation constitutes an overordered system of vulnerability reduction, even if only referred to the frontier properties. In fact, all the previous features can also be associated with physical BE objects within the Outdoor Areas that limit or modify access to external areas of attractive buildings. The distance between flowerpots or benches constitutes an example. Finally, the Accessibility index has a prevalent relevance for all the attacks that involved vehicles.
- [V_I.3] The Obstacles ($i_{OBS(V)}$): the descriptor refers to all the urban furniture inside the urban Outdoor Areas which affect the vulnerability level of the risk. Here, the obstacles refer to all the BE elements—furniture, geomorphological discontinuities (stairs); sights—fixed or temporal—that generate social meeting points (rendezvous, hangouts) [52], as well as cultural or touristic attractions (e.g., monuments, fountains). It is the case of dehors for restaurants or bar, staircases and benches, or green areas, as physical elements located both along the frontier or inside the Outdoor Areas. In this sense, the index includes the obstacles that may increase the vulnerability of the places as "soft targets" themselves (TP.3.2).

Finally, the recognition of indexes related to the exposure focuses on the number of victims and injured following a potential victim-centered analysis (the damages to buildings are excluded). Thus, the exposure indexes aim at the identification of features of Outdoor Areas directly or indirectly involved in increasing victim exposure, and specifically:

- [E_I.1] The Attack Type (i_{att}): this is the index related to the consequences levels (in terms of victims and injured persons) of the AT combined with the OutECs, according to the Statistic analysis in the previous section (T2, Section 4). This is also in line with the European suggestion in managing strategies for emergencies, suggesting studies where solutions should consider the possible Attack Types [49,52].
- [E_I.2] The crowd level in the Outdoor area (i_{crw}): here, the index defines the potential impact in terms of victims and injured persons, and refers to the crowd classes (person/m^2); here, the index is strictly related to the use of Outdoor Areas or external areas related to buildings uses, above all for B and D ECs resulting from the previous analysis (T2, Section 4). Unlike the index of use identified for H_I.2, the crowd level must be expressed as the potential density of people involved in the attacks. The relevance of building uses and relative external areas is referred to the concept of "Space of Relevance": according to the positioning of access points inside the buildings

and to their main uses, some external areas could be affected by different levels of crowding in a determined external area [52].

- [E_I.3] The attack reaction (i_{REA}): the index refers to the inherent OutECs reaction for each Attack Type, considering the easy escape or protection levels for users, as well as the presence of countermeasures or urban furniture inside the area. In this sense, the "psychological" dimension of users is not considered, as well as their preparedness for the event. Obstacles are among the BE elements to be considered in this index. However, unlike the Vulnerability assessment, obstacles influence the impact in two ways; focusing on the European experience in educating citizens, the presence of objects can constitute a passive system of protection during the attack [55–57]. However, urban furniture is associated with an incrementing factor in exposure, when they constitute a system of obstacles along the evacuation paths [52,56,57]. Due to these features, obstacles located inside the outdoor areas should be considered not only for their geometric prevalent characters (height, diameters, etc.), but also for their inherent influence in protecting people from the attack (that depends on the type of attack itself) and in interfering with emergency paths and exits [54]. Unlike protective systems along the frontiers of Outdoor Areas, which are usually standardized according to speed resistance against ramming vehicles, these obstacles are usually unqualified for resistance qualities but recognized only for their qualitative inherent capacity to protect people (the relevance of obstacles in protecting people derives mostly from the assessment of educative national initiatives in managing the emergency [56,58,59]). Likewise, the attack reaction index includes the presence of specific urban furniture that constitutes a physical countermeasure to terroristic attacks. As discussed for previous indexes, countermeasures should be assessed for the efficiency to specific Attack Type (T2, Section 4).

6. Discussion of Results and Conclusions

Terrorism is part of current studies assessing future secure and resilient cities prone to disasters. Despite the inherent quality of anthropic disasters, several contact points with natural events can be found for strategies and approaches for its study. On the other hand, the predominance of the human will changes the traditional relations between the event and the effects, involving the perpetrator's choice of place and the change in their goal. In this whole framework, the terrorist threat is not supported by strong scientific and technical studies, also due to safety and security issues. The main discussion on the events is related to the USA due to their political and cultural relevance to the matter. With the increasing attention on the European continent, most American experiences were transposed trying to capture the main goals and strategies. However, applications and detailed studies refer to strategic buildings and massive events. Recent traumatic events in ordinary places have changed the perception of terroristic threat, increasing the attention to public security outside the big events.

By considering previous experiences in the discussion of the terroristic events, this work wants to solve the monothematic and mono-timing attention to the threat in Europe, (i) overcoming the studies focused on the critical infrastructures and the economic effects of the attacks and (ii) combining preventive assessment of the risk to its management during the events. In the first case, it is fundamental in order to focus on the widest parts of the cities which represent the "softer" ones as inherent unprotected areas. Secondly, to support the urban administration in determining the risk potentialities with smart methods of assessment mainly based on the consideration of a reduced set of critical features.

In this context, the present work aims to reach four different goals, presenting equivalent levels of results:

1. The discussion of terrorist threat in real European outdoor areas of cities in order to discuss their potential risk exposure, as a consequence of the phenomenological analysis. Here, the significance of UBEOAs as "ordinary urban spaces" (B, D and F Environmental Classes) has been highlighted, showing the high relevance in likelihood

(possible event, one event per week) and consequence (medium to extreme effects, 30 to more than 3000 people involved). In that sense, the parametrization of European events as couple of Attack Types and Environmental Classes allows understanding of the phenomenological threat to the identification of most recurrent and hitting ones.

2. The assessment of UBEOAs risk exposure, relating them to the use of the most exposed function of buildings facing the outdoor areas and combining the weaponry types. For them, Armed Assault and Bombing/Explosion results are recognized as the most recurrent and the most efficient for the maximization of the effects. Moreover, the assessment of the phenomenon in the reduced sample has highlighted two major points of discussion: firstly, that T7, as adjunctive and more frequent AT in the whole sample, has minor relevance; then, that the severity of T2 and T3 Attack Types increases when the selected OutECs are considered. These elements can be argued considering the number of people involved. According to the necessity to maximize the effect, most T7 attacks take place in the inner part of ECs, where higher crowd levels can be found. On the other hand, the opportunity to study the phenomenon for outer parts of buildings remarks on people's habit of staying outside public buildings for a long time, increasing the inherent vulnerability of certain places. This is also confirmed by the upgrading process from moderate, medium and major consequence levels to lower ones when OutEC/AT and EC/AT combinations are compared (Tables 6 and 8).
3. The creation of matrixes of risk is useful for the analysis of urban Environmental Classes combined with weaponry, as a smart and simplified tool for the first level of understanding for UBEOAs exposure to the hazard. Specifically for the work, matrices allow the identification of major efficient ATs and ECs coupled as a threat to focus on specific classes of ECs and OutECs. In fact, the lack of literature about such risk management in Europe means there is currently no way to determine which kind of threat (where and how) appears to be most relevant. From a more general point of view, the setup of the matrices constitutes the opportunity to provide a comprehensive overview of the European phenomenon, providing a smart and fast instrument for the comparative assessment of risk exposure in the whole city categorized in classes. Moreover, the use of matrices offers the opportunity to compare such risk to other ones already and fully discussed (e.g., seismic activity and flood risks).
4. The parametrization of such urban areas in the most critical condition (Attack Types and functions), according to the main Risk Determinant (Hazard, Vulnerability, Exposure) and the physical elements in the BE. Here, the processes have highlighted the recurrence of inherent parameters involved in the phenomenological assessment, such as the Attack Type, the use of the places and buildings within the Outdoor Areas, as well as the symbology of the target. On the other hand, the main morphological and physical properties of the BE have emerged from the analysis, specifically:
    - Obstacles, referring to all the elements that have a geometry and physical presence inside and along the frontier of the Outdoor Areas that can interfere with people (both users and perpetrators). Mitigative systems (i.e., barriers, traffic controllers) are part of such classes interfering with the increasing level of likelihood of the events; however, major relevance for the study is associated with the urban furniture (fixed or mobile) and monuments for their double effect on the inherent level of vulnerability of the place, as well as the variation in the exposure level when such elements can be identified as inherent protective systems for the users. In this sense, results have emphasized an opposite point of discussion, pointing out the necessity for analysis of the present urban obstacles to study their potential increasing or decreasing potential with regard to the risk (usually, obstacles have a negative effect on the path, mitigative elements positive on the risk reduction). As a complementary discussion, the presence of mitigative systems should be also studied for the possible interferences with other risks which involve mass escape.

- The geometric relevance of the places, as their quality to interfere with the total vulnerability level, above all when vehicle attacks are considered. The accesses and their morphological characters can represent an inherent barrier to terroristic events. On the other hand, the main morphological features of the place (e.g., compact or elongated) can influence the vulnerability, too. This is coherent with all the rapid traumatic events that generate fast evacuation processes (e.g., seismic activity, floods). Correlating obstacles to geometric relevance, the use of movable or fixed mitigation systems can support the management of people and the perception of places, in accordance with the discussed theory of "Security by design".

This parametrization process of the BE related to the risk determinant constitutes the first step in determining a proper procedure for the risk assessment of such places. Instead, the parametrization process and quali–quantitive assessment will support the practices for risk "management" and "communication". In fact, the representation of the hazardous levels, the identification of mitigative strategies and their position, firstly, and the dissemination of preventive best practices and behavioral education during the emergencies constitute the final goals for the direct involvement of technical and urban users as human components in future resilient cities.

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Abbreviations

Table of abbreviations used in this paper:

GTD	Global Terrorism Database.
EC	Environmental Class.
OutEC	Outdoor Environment Class.
AT	Attack Type.
UBE	Urban Built Environment.
UBEOA	Urban Built Environment Outdoor Area.

Appendix A

Table A1. Categorization in Environmental Classes of target Sub-types of GTD classification.

EC	TARGET SUB-TYPES (GTD CLASSIFICAZION)
	Business
B	Gas/Oil/Electric
B	Restaurant/Bar/Café
B	Bank/Commerce
B	Multinational Corporation
B	Industrial/Textiles/Factory
B	Medical/Pharmaceutical
B	Retail/Grocery/Bakery
B	Hotel/Resort
B	Farm/Ranch
B	Mining
B	Entertainment/Cultural/Stadium/Casino
B	Construction
B	Private Security Company/Firm
B	Legal Services
	Government (General)
N	Judges/Attorneys/Courts
N	Politician or Political Party Movement/Meeting/Rally
N	Royalty
N	Head of State
N	Government Personnel (excluding police, military)
N	Election-related
N	Intelligence
N	Government Buildings/Facility/Office
	Police
D	Police Buildings (Headquarters/Stations/School)
D	Police Patrol (including vehicles and convoys)
D	Police Checkpoint
N	Police Security Forces/Officers
D	Prison/Jail
	Military
D	Military Barracks/Base/Headquarters/Checkpoint
D	Military Recruiting Station/Academy
D	Military Unit/Patrol/Convoy
D	Military Weaponry
D	Military Aircraft
D	Military Maritime
N	Non-combatant Personnel
N	Military Personnel (soldiers, troops, officers, forces)
D	Military Checkpoint
D	Military Transportation/Vehicle (excluding convoys)
N	North Atlantic Treaty Organization (NATO) Related

Table A1. *Cont.*

EC	TARGET SUB-TYPES (GTD CLASSIFICAZION)
N	Paramilitary
	Abortion Related
B	Clinics
N	Personnel
	Airports and Aircraft
A	Aircraft (not at an airport)
N	Airline Officer/Personnel
A	Airport
	Government (Diplomatic)
N	Diplomatic Personnel (outside of embassy, consulate)
D	Embassy/ Consulate
D	International Organization (peacekeeper, aid agency, compound)
	Educational Institution
N	Teacher/Professor/Instructor
C	School/University/Educat. Building
N	Other Personnel
	Food and Water Supply
N	Food Supply
N	Water Supply
	Journalists and Media
N	Newspaper Journalist/Staff/Facility
N	Radio Journalist/Staff/Facility
N	Television Journalist/Staff/Facility
N	Other (including online news agencies)
	Maritime
N	Civilian Maritime
B	Commercial Maritime
N	Oil Tanker
A	Port
	NGO
N	Domestic NGO
N	International NGO
	Other
N	Ambulance
N	Fire Fighter/Truck
N	Demilitarized Zone (including Green Zone)
	Private Citizens and Property
N	Refugee (including Camps/IDP/Asylum Seekers)
N	Unnamed Civilian/Unspecified
N	Named Civilian
N	Religion Identified
N	Student
N	Race/Ethnicity Identified
N	Farmer
F	Vehicles/Transportation
F	Marketplace/Plaza/Square

Table A1. *Cont.*

EC	TARGET SUB-TYPES (GTD CLASSIFICAZION)
F	Village/City/Town/Suburb
E	House/Apartment/Residence
N	Laborer (General)/Occupation Identified
F	Procession/Gathering (funeral, wedding, birthday, religious)
F	Public Areas (e.g., public garden, parking lot, garage, beach, camps)
B	Memorial/Cemetery/Monument
B	Museum/Cultural Center/Cultural House
B	Labor Union Related
N	Protester
N	Political Party Member/Rally
N	Alleged Informant
	Religious Figures/Institutions
N	Religious Figure
B	Place of Worship
B	Affiliated Institution
	Telecommunication
B	Radio
B	Television
B	Telephone/Telegraph
B	Internet Infrastructure
B	Multiple Telecommunication Targets
	Terrorist/Non-State Militia
N	Terrorist Organization
N	Non-State Militia
	Tourists
B	Tourism Travel Agency
A	Tour Bus/Van/Vehicle
N	Tourist
N	Other Facility
	Transportation
A	Bus (excluding tourist)
A	Train/Train Tracks/ Trolley
F	Bus Station/Stop
A	Subway
A	Bridge/Car Tunnel
A	Highway/Road/Toll/Traffic Signal
A	Taxi/Rickshaw
	Utilities
N	Gas
N	Electricity
N	Oil
	Violent Political Parties
N	Party Official/Candidate/Other Personnel
B	Party Office/Facility
F	Rally

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