

Urban Planning and Design for Terrorism Resilient Cities

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The actuality of this research is determined by a significant number of recent terror attacks and their disastrous impacts on urban forms. The target of terror attacks has moved from developing to developed countries. Existing urban polices in most countries do not meet counterterrorism standards. Consequently, implementation of counter-terrorism guidelines while planning safe places has turned into essential factor for the 21st century design.

The research comprises identification of environmental design (CPTED) factors as well as spatial urban structures that influence the choice of places for terror attacks. 14 sites with terror attacks and 21 sites without terror attacks were assessed according to the developed CPTED questionnaire. For understanding spatial urban structure 6 cases have been analyzed with space syntax method.

The research results reveal that the following CPTED factors are related to the choice of place of terror attacks: Strong separation of private and public activities; Site that has a direct access to the main street; Site that has a multiple entrances and exits; Minimization of vehicle access points to the building; Access to private and public space; Site that has a direct access to the city center; Site is well-used; Redistribution of same functional buildings on the site; Presence of a medical institution nearby the site.

According to the results of the automatic regression analysis, the following CPTED factors do the biggest impact on the choice of places for terror attacks: 1) vehicle access points to the buildings are minimized, 2) public and private activities are separated, 3) there are many same functional buildings redistributed in the surrounding area. Descriptive statistics reveal the weakest points on the analyzed sites: 1) public and private activities are not separated, 2) many same functional buildings are not redistributed in the surrounding area, 3) access points to the building are not minimalized, 4) the object is surrounded by an open space, 5) there is no security police presence at the site, and 6) there no minimum required setback distance between the building and site boundaries. After the visual comparison of segment maps of integration, choice, mean depth and connectivity, we have discovered that almost all terror attacks happened on the most globally integrated (R=n) street segments, except Tel Aviv case study. Finally, the recommendations for the elements of site reorganization and the elements of street network reorganization are proposed.

KEYWORDS: CPTED, environmental design, terrorism prevention, urban planning.

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Introduction

Acts of terrorism is not a new phenomenon. Number of developing as well as developed countries have been facing up with the problem of protecting areas with high values in search of eschewing unforeseen casualties. Urban planning is one of those fields responsible to investigate and mitigate a potential threat of terror. It is an undeniable fact that security has always been a significant part of cities and their architecture, and it has strongly influenced the pattern of development of cities and settlements. Security had been achieved by strong fortifications, a tactic decision on location of settlements on hills, on high mountains, settlements surrounded by the water, etc. Nowadays, when urban sprawl has become quite common, whereas, city planners are 'engaged' to already planned urban environment where minor changes can be hardly implemented. However, some contemporized ideas from medieval times still can be seen in modern designs for safer cities. A relevant example here could be London Ring of the Steel that could be understood as a modern way of fortifying the city. Main principle of the design is a vivid separation of exit and entry points to and from the site, that is maximally controlled. Two direction movements are abolished most of the roads are turning into one way roads, that gives a natural surveillance on the site. Officially, the 'ring of steel' is called the 'Experimental Traffic Scheme,' and the project is marketed as an environmental and traffic congestion reduction strategy. It is interesting to note, that terrorism is a quite young field of research and researchers have not been able come up with a general definition of terrorism (Hogan 2009, Coaffee 2009, Horgan 2014, Bjorgo and Horgan 2009, Atlas 2013, Purpura 2015, Lutz 2013, Howard and Hoffman 2011, Coaffee and Bosher 2008, Glaeser and Shapiro 2011, Godschalk 2003, Rothrock 2010). With the spread of terrorism in recent decades, security has become an inevitable feature of modern urban life, particularly for those who live and work in the capital cities, especially in important buildings related to political or religious activities, as well as public crowded places have become unprotected. Government is now obliged to take the appropriate precautions to protect against terrorist attacks of many sorts. However, the problem still affects many urban cities and areas, especially in European cities, where terrorism is quite new.

Choice of the target of terror attacks. The history of terrorism in urban environment has highlighted the fact that choice of terrorist targets is mainly depend on the characteristic features of environment. Usually terrorists choose their targets to maximize the impact of their attack, or rather its consequences, and minimize the effort. They rarely attack 'hard' targets, those that are fortified or defended, such as military installations. They prefer so-called 'soft' targets, such as commercial shopping malls or football stadiums, where a successful attack might produce the greatest effect. This effect may involve anything, from massive casualties or physical destruction intended as symbolic acts to induce psychological shock, demonstrate a community's vulnerability, and instill fear. Crowded places remain an attractive target for international terrorists because of their ease of access, little protective security and the prospect for high casualty rates and political impact in the event of a successful attack. As such, the majority of counter-terror focus on the built environment is on crowded places. The US Home Office defines a crowded place as 'a location or environment to which members of the public have access that may be considered potentially liable to terrorist attack by virtue of its crowd density'. These include transport hubs, sports stadiums, pubs/club bars, shopping centers/high streets, visitor attractions, cinemas and theatres, commercial centers. Crowded places can also include the public realm such as parks and squares. Therefore, the first and the most important duty for countries security organizations is evaluation of which buildings, infrastructures or areas in general are likely to be a target of a terrorist attack.

According to all above mentioned, the paper questions how to get terrorism resilient sites with considering counter-terrorism principles for safer environment, simultaneously creating usable urban environment.

CPTED - Crime Prevention Through Environmental Design. The actuality of this research is determined by a significant number of recent terror attacks and their disastrous impacts on urban

forms. The target of terror attacks has moved from developing to developed countries that have already experienced number of attacks in a last few decades. Consequently, terrorism turned into a harmful hazard for most European cities. Existing urban polices do not meet counterterrorism standards and guidelines, especially in European countries. The necessity of implementation new environmental standards, as well as equipment of major buildings in high risk areas with elements, against terror attacks has turned into essential factor for the 21st century design. An examination of CPTED (Crime Prevention Through Environmental Design) and its goals of crime prevention are especially strategic in terms of the seemingly crime-producing environments of some antiterrorism design. Antiterrorism design often creates a hostile environment for daily users by scarring downtowns with desolate security zones, repetitive rows of bollards, and threatening architecture. Possibly, the interventions designed to keep people safe from terrorists are putting people in danger of increased day-to-day crime. To counteract this unpredicted outcome, as well as discourage inhuman architecture and site design, CPTED strategies and tools should be fully integrated with antiterrorism design principles in a holistic approach to safety, security, and Civic Design. This paper presents the analysis of urban spaces in different countries where the most recent terror attacks were committed. Based on the analysis results, the recommendation for urban planning and environmental design are proposed.

The aim of the research is to identify environmental design factors (based on CPTED) as well as spatial urban structure (based on space syntax method) that influence the choice of places for terror attacks. Therefore, the research consists of two parts: 1) identification of environmental design (CPTED) factors that influence the choice of places for terror attacks, and 2) identification of factors of spatial urban structure that influence the choice of places for terror attacks.

For the identification of environmental design (CPTED) factors that influence the choice of places for terror attacks, the CPTED questionnaire based on the foreign experience (CPTED site assessment checklists and FEMA Guidelines for counterterrorism principles) was developed, and the evaluation of urban sites according to the CPTED questionnaire was performed. The CPTED questionnaire consists of 39 Yes/No type questions that are organized in five different blocks according to CPTED strategies: 1) Elements of surveillance; 2) Elements of access control and target hardening; 3) Elements of territoriality, 4) Elements of site managements, 5) Elements of activity support. According to the recent terrorist map, the following cities with places of the most recent terror attacks were selected for the first part of the research: Brussels, Liege, Oslo, Paris (2 sites of terror attacks), Volgograd, Diyarbakir, Stockholm, Ankara (3 sites of terror attacks), Istanbul (2 sites of terror attacks) and Tel-Aviv. Therefore, 14 sites with terror attacks and addition to them 21 sites without terror attacks, have been analyzed. It is important to mention that all the chosen cases with terror attacks are either suicide bombings, mass shooting, car bombing or all together. All the sites are observed using Google Street View tool. For the identification of factors of environmental design (CPTED) that are related to the choice of places for terror attack the correlation analysis is applied. For the identification of importance of CPTED factors on the choice of places for terror attacks the automatic regression analysis is applied. For highlighting weakest points of the analyzed objects with terror attacks in terms of CPTED the descriptive statistics is applied. The scheme of the research methodology is presented in the Fig. 1.

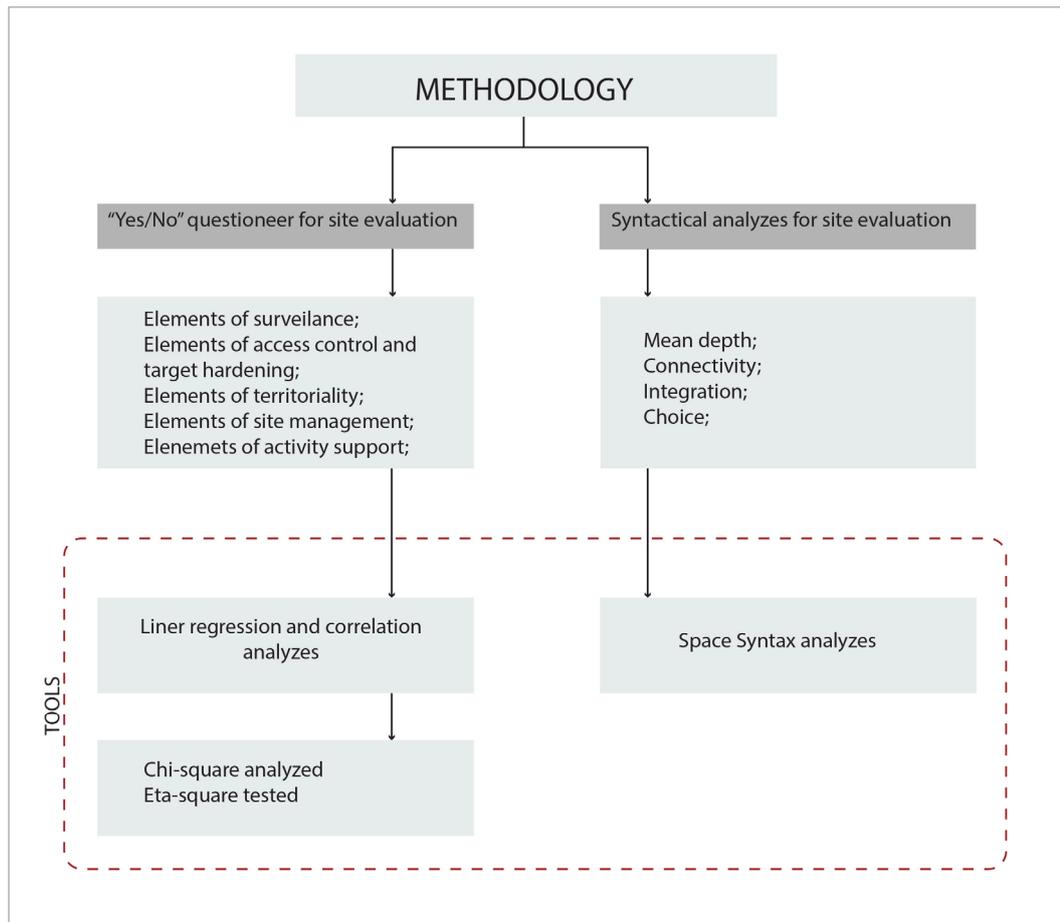
The second part of the research, identification of factors of spatial urban structure that influence the choice of places for terror attacks, comprises making syntactic maps of cities based on the space syntax method. The following case studies are selected for the space syntax analysis:

- _ Ankara 2015 October (G. Mustafa Kemal Blvd.);
- _ Ankara 2016 February (Military headquarter);
- _ Ankara 2016 March (Ataturk Blvd.);

Methods

Fig. 1

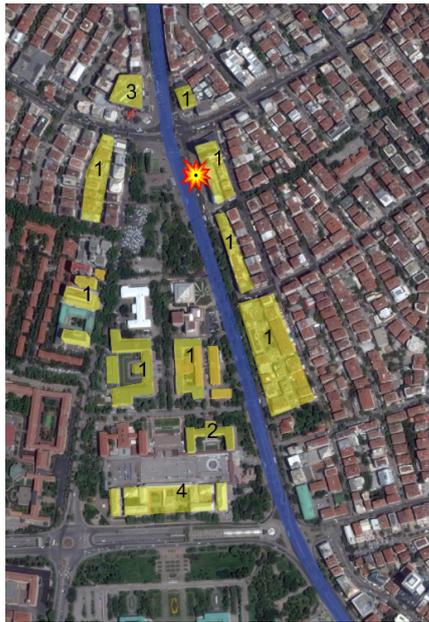
Research Methodology



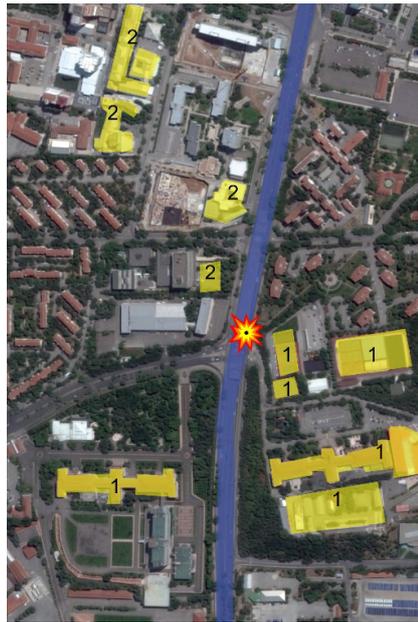
- _ Brussels 2016 (Maelbeek Metro Station);
- _ Istanbul 2016 (Istiklal avenue);
- _ Tel-Aviv 2016 (Dizengoff street).

One of the main determinants of choosing only six sites from fourteen (Fig. 2) was caused by difficulties in making precise maps for the syntactic analysis. Also, as far as the most cities have implemented new environmental design tools for the improvement of site security after terrorist attacks we have selected only the most recent cases of terror attacks for this part of the research. For the syntactic analysis the segment maps are prepared from the axial maps for each case study. Urban area of 8 km in diameter with a terror attack in the center was analyzed for each case study. DepthMap software is used for the drawing of segment and syntactic maps as well as for the calculation of values of syntactic properties of urban spaces. The following syntactic properties of urban spaces are analyzed:

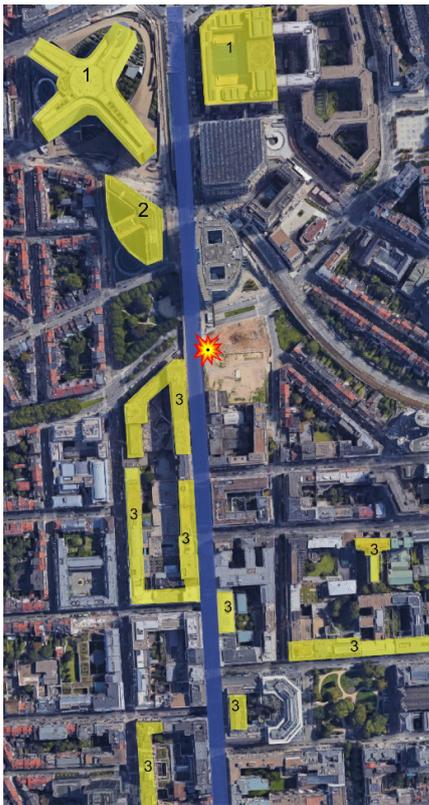
- _ Choice (n, R2, R3 and R5 radii) is used to identify the streets that are most commonly chosen for traveling.
- _ Connectivity will identify street segments with significant number of connections with other urban spaces.
- _ Integration (n, R2, R3 and R5 radii) is used to identify the street segments that are the most or least integrated.
- _ Mean depth (n, R2, R3 and R5 radii) will clarify how deep or shallow street segments are related to the places of terror attacks.



Ankara, March 2016
 1. Governmental offices
 2. Public work departments;
 3. Shopping center
 4. Financial offices;



Ankara, February 2016
 1. The armed force school Headquarter of the army
 2. Governmental building;



Brussels, March 2016
 1. EU commission building
 2. Business center
 3. Governmental building



Istanbul, March 2016
 1. Mixed use Food objects
 2. Mixed use Shopping
 3. Leisure Centers
 4. Governmental Building
 5. Mosque

Fig. 2

Sites with terror attacks that have been analyzed in the second part of the research (spatial urban structure)

Results

Terror attacks and environmental design factors (CPTED). The aim of this part of the research is to identify if any factors of environmental design (based on CPTED) are related to the choice of place for the terror attack. 14 sites, that were affected by terror attacks, and 21 sites, that were not affected by terror attacks, have been evaluated, according to the CPTED questionnaire. For the identification of relations between categorical variables (environmental design factors from the questionnaire that can be answered as Yes or No) and scale variables (number of terror attacks) Eta-squared correlation analysis and Chi-squared test are applied. A measure of association Eta-squared ranges from 0 to 1, with 0 indicating no association between the row and column variables and values close to 1 indicating a high degree of association. Eta-squared is appropriate for a dependent variable measured on an interval scale (interval and ratio variables are combined in the scale variable in SPSS) and an independent variable with a limited number of categories. Small correlation is being observed at $n^2 \sim 0.02$, medium correlation is when $n^2 \sim 0.13$, large correlation is when $n^2 \sim 0.26$. The Chi-squared test is used to determine whether there is a significant relation between the 2x2 table variables. For the identification of urban factors, that affect terrorism, linear regression analysis is applied. Statistical Package for the Social Sciences (SPSS) is used for the implementation of this research.

According to the correlation analysis (Eta-squared is calculated and Chi-squared test is applied) results, there are relations between terror attacks and the following factors of environmental design (CPTED):

- A strong separation of private and public activities is related to terror attacks ($\chi^2=14.583$, $p=0.00 < 0.05$ and $n^2=0.521$, $p=0.00 < 0.05$). A strong separation of public activities from private businesses can make them easier to be controlled and secured. However, with the actuality of retail activities separate entrances and controlled independently can be understood as one of counterterrorism principles. Private areas should be defined by small fences and site boundaries. A strong separation of private areas and public areas will reduce crime rate and terrorist activities respectively.
- A site that has a direct access to the main street is related to the terror attack cases ($\chi^2=4.762$, $p=0.029 < 0.05$, $n^2=0.170$, $p=0.029 < 0.05$). When the site has an easy access to the main street, it means it is located in a major area of the city, and the interest in it is quite significant. Consequently, in most cases this feature is associated with terror attack cases.
- A site that has multiple entrances and exits are more likely to turn into the target of terror attacks ($\chi^2=5.250$, $p=0.022 < 0.05$, $n^2=0.188$, $p=0.021 < 0.05$). Bigger number of entrances and exits to the site is associated with a bigger number of less defensible problematic areas. According to FEMA guidelines (FEMA 2003a, 2003b), a site should have two entrances and exits (one of them for emergency purposes).
- Minimization of vehicle access points to the building is related to terror attacks ($\chi^2=5.000$, $p=0.025 < 0.05$ and $n^2=0.333$, $p=0.024 < 0.05$). Controlling all existing vehicle access points is necessary for counterterrorism planning. Although minimalizing the number of accesses to the object can diminish chances of terror attack, and therefore, give us a possibility to make minimal standoff distances from the object to the vehicle.
- Access to private and public space is clearly defined ($\chi^2=6.087$, $p=0.014 < 0.05$, $n^2=0.217$, $p=0.012 < 0.05$). Finishes and signage should be designed for visual simplicity.
- When a site has a direct access to the city center it more likely turns into a target of terror attack ($\chi^2=6.300$, $p=0.012 < 0.05$, $n^2=0.225$, $p=0.011 < 0.05$). According to the research, a site that has a direct access to the city center is considered as an important area. Owing to the fact that terrorist's main aim is to attack easy targets and achieve huge number of loss at the same time. Centers and major integrated roads mostly turn into a target of terror attacks.

- _ Site is well used ($\chi^2=6.087$, $p=0.014<0.05$ and $n^2=0.217$, $p=0.012<0.05$). Well used site means it has many visitors. Crowded places are always hard to control, consequently this circumstances can turn it into an unsafe place and an easy target for terrorists.
- _ Redistribution of same functional buildings on the site can turn the area into the place of terror attack ($\chi^2=7.337$, $p=0.014<0.05$ and $n^2=0.217$, $p=0.012<0.05$). Governmental districts, cultural districts can turn into an easy target for terrorist organization, as far as same functional buildings are redistributed in the same area.
- _ A presence of a medical institution nearby the site is related to the choice of place for the terror attack ($\chi^2=7.350$, $p=0.007<0.05$ and $n^2=0.490$, $p=0.004<0.05$).

The automatic regression analysis reveals the importance of CPTED factors on the choice of places for terror attacks. The Fig. 3 demonstrates how important the variables 8, 20, 28, 30, 32, 33, 34 and 36 are for the choice of places for terror attacks:

- _ Variable 8 corresponds to the question 'Are there multiple entrances and exits to and from the site?'
- _ Variable 20 corresponds to the question 'Are vehicle access points to the buildings minimized?'
- _ Variable 30 corresponds to the question 'Is there any medical institution nearby the site?'
- _ Variable 33 corresponds to the question 'Are public and private activities separated?'
- _ Variable 36 corresponds to the question 'Are there many same functional buildings redistributed in the surrounding area?'

According to the Fig. 3, the variables 20, 33 and 36 have shown the strongest importance for the choice of places for terror attacks, that means elements of activity support and site function might be considered as determinant factors that can turn the area into a choice of terror attack.

To be more precise, when public and private activities are separated, they have different access points and different system of security, these circumstances can reduce threat of terror. As for zoning, it appeared to be almost as important as separation of activities. Redistribu-

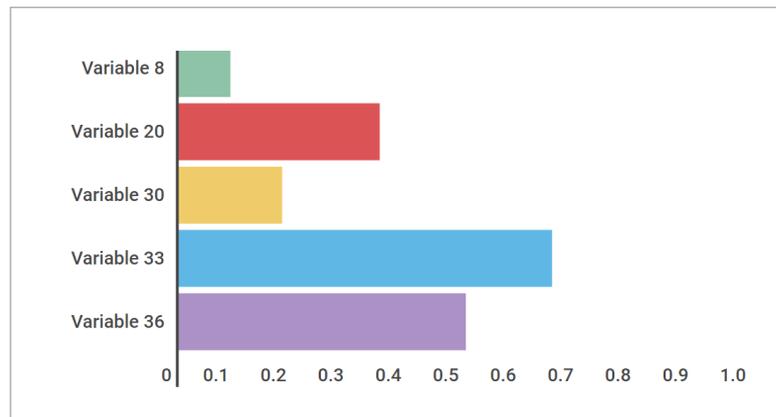


Fig. 3

Importance of variables for the choice of places for terror attacks

tion of same functional buildings in the high density areas can make the place less secured. Both features can be successfully implemented in counterterrorism design.

The results of the descriptive statistics analysis reveal the weakest points of the analyzed objects with terror attacks in terms of CPTED. CPTED factors that have the biggest number of negative evaluations ('No' answers) are considered as the weakest points that should be improved in order to reduce the risk of a terror attack (Table 1). For this part of the research only the sites (14 sites) that have been affected by a terror attack are evaluated.

Descriptive statistics has shown that most of the site where terror attacks happened were surrounded with open space. Therefore, we can deduce that even though open space can be benefi-

Table 1

The weakest points in the analysed objects that have been affected by a terror attack (according to CPTED)

CPTED factors that need improvement in the analyzed objects	Number of negative answers out of 14
Are public and private activities separated?	13
Are there many same functional buildings redistributed in the surrounding area?	12
Vehicle access points to the site are minimalized	11
Is there security police presence at the site?	10
Is there a minimum required setback distance between the building and site boundaries?	10

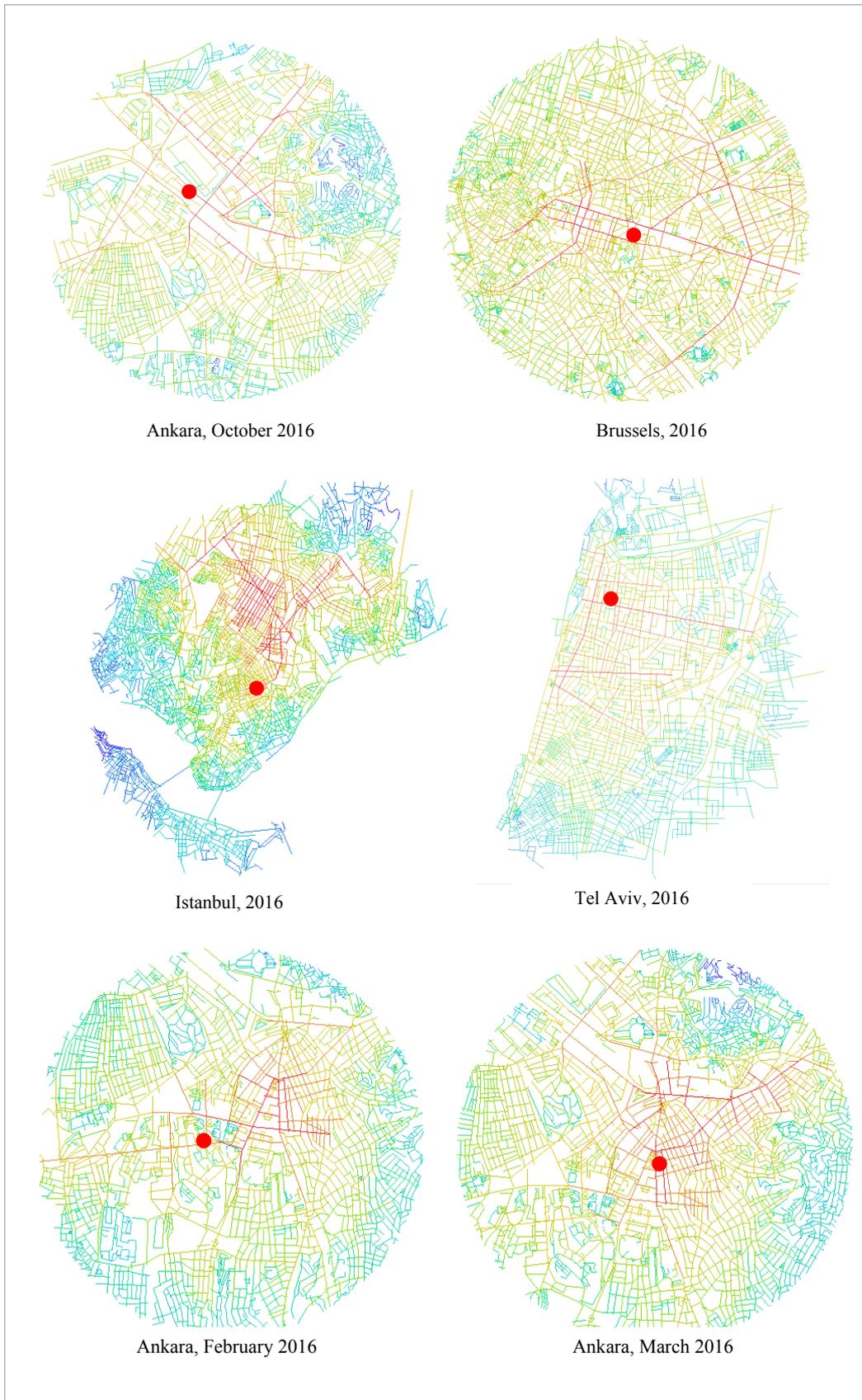
cial for architectural point of view (for maximizing standoff distance, or easily redistributing blast loads) it can turn an object into a target for terrorist attacks. A similar explanation can be made for the factor 'Vehicle access points to the building are minimalized': when the site is located on the major road, its importance is higher so as its asset value is significantly high as well. According to the counterterrorism principles, a site should have no more than two controlled accesses points (FEMA 2003a, 2003b). Though, we see from the descriptive statistics results that on 11 sites out of 14 the vehicle access points to the building are not minimalized. Therefore, they have multiple entrances to and from the site that can be also considered as a determinant factor of an attack. Almost none of examined places had any nearby police stations, this circumstance could have led to taking unseasonable measures. The most of cases have easy vehicular access points that rises the vulnerability of a building for vehicle penetration. Setback distance has also highlighted a common problem: not existence of sufficient standoff distance from the building and site boundaries turns the object into an easy target for terrorist groups. It turned out that just 4 sites out of 10 have sufficient standoff distances. The choice of places for attacks could also be determined by their easy access to the city center: 13 sites out of 14 have a direct access to the center. Analyzed data has shown that separated public and private activities can be a reason for terrorist cases. 12 cases have occurred in particular spatial space configuration, where clear zoning plan is dominant and same functional buildings are not redistributed in the surrounding area.

The results from descriptive statistics of sites with terror attacks are strongly correlated with previous research of data correlation analysis. Consequently, some similar environmental features can be identified in the data provided by a comparative analyzes of a questionnaire to correlation analyses results. This data will therefore highlight the most important elements that should be implemented into design, such as: entrances to and from the building, vehicle access points to the building, direct access to the city center, and separation of public and private activities, well-used site and same functional buildings redistribution in the surrounding area.

Terror attacks and spatial urban structure. The aim of this part of the research is to identify if any factors of spatial urban structure are related to the choice of place for the terror attack.

The visual analysis of syntactic maps for six sites with recent terror attacks has pointed out some elements and urban patterns that can be the main determinant of choosing areas for committing terror attacks. Redistribution of a street network has come out a key factor while planning resilient cities.

After the visual comparison of segment maps of integration, choice, mean depth, and connectivity, we have discovered that almost all terror attacks happened on the most globally integrated ($R=n$) street segments, except Tel Aviv case study (Fig. 4). Tel-Aviv was the only city where terrorist attack site was not located on the most integrated street, though it had quite high choice and local integration values.

**Fig. 4**

Integration maps (R=n) for the research objects. A terror attack is marked as a red dot. Red-orange lines mean the highest values of integration, and blue-green lines mean the lowest values of integration

Recommendations

According to the research results and literature analysis, the recommendations for building the terrorism resilient cities are developed (Fig. 5):

Elements of site reorganization:

Access control:

- _ Site should not have multiple entrances and exits, 2 entrances are preferable;
- _ All exit and entry points should be controlled (CCTV cameras, sufficient lightning);
- _ Vehicular access to the site should be minimalized;
- _ Accesses to public and private buildings should be defined;

Building disposition:

- _ Sufficient standoff distance from the building to the site perimeter should be respected;
- _ Overground parking lots must be far enough from the building;
- _ Open space should be around the building, but not around the site;

Site – 'Do':

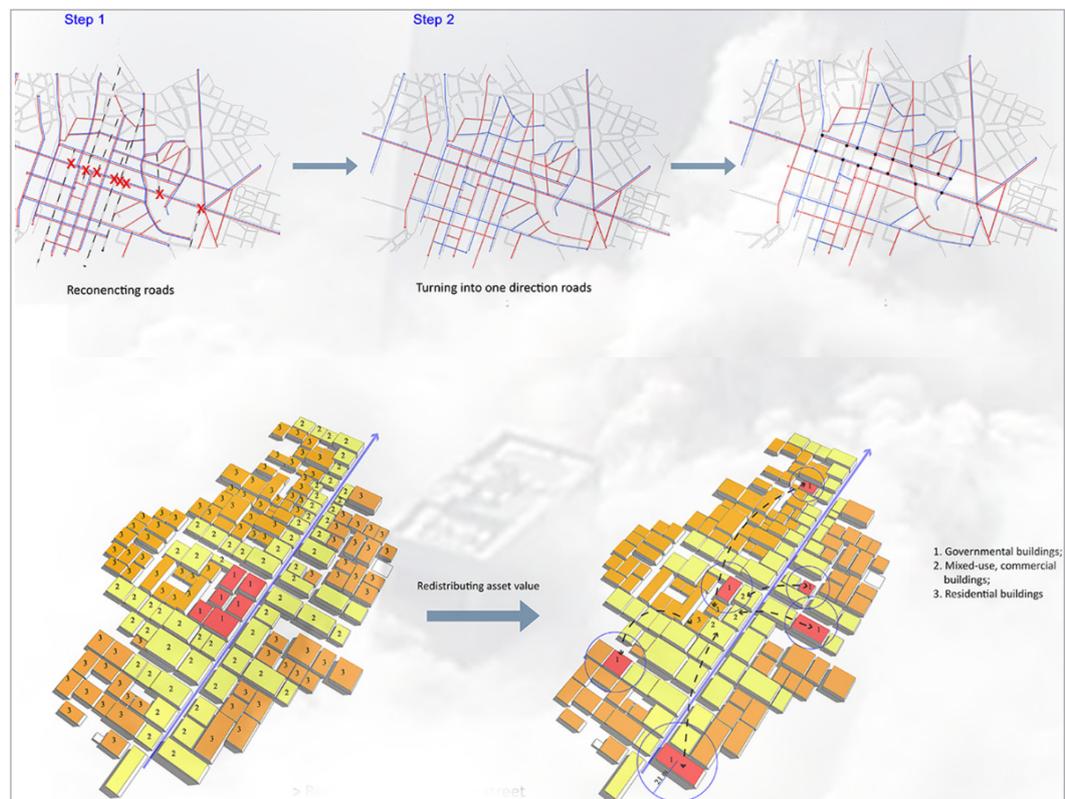
- _ 'No direct access to the main street' rule should be followed;
- _ 'No easy access to the city center' rule should be followed;
- _ Redistribution of building complexes to the surrounding zones;
- _ Reinforced perimeter buildings according to already approved evacuation and mandatory distances;
- _ Relevant lighting during night across the perimeter.

Elements of street network reorganization:

- _ Streets with high global integration level are unprotected against terror attacks, therefore, they must be reorganized (Fig. 5).

Fig. 5

Some recommendations for reducing the risk of the terror attack. Above: street network reorganization. Below: relocation of target buildings



Conclusions prepared for both spatial urban as well as for environmental design (CPTED) factors. For *elements of site reorganization*, research concluded that site should not have multiple entrances and exits as it turns the area into a vulnerable place. Moreover, controlling multiple exit and entry points is associated with many expenses. Recent studies on terrorism cases highlighted importance of reducing easy vehicular accesses to the site, as far as vehicles penetrating directly into the building or even bomb explosion by various means of transportation are quite common. Consequently, parking lots are located close to major buildings. The research has deduced that vehicle access should be minimalized, that can also be associated with access management. According to FEMA principles (FEMA 2003a, 2003b), The number of access points into a site should be minimized, because they are a potential source of weakness in the controlled perimeter, and they are costly in construction and personnel. However, at least two controlled access points should be provided in case one is shut down by maintenance, bomb squad activity, or other causes. Related to this element, standoff distance from the building and perimeter barriers are crucially important as well. Studies have shown that the minimum setback distance is 21 meter in search of resilience against suicide vast. However, it is not enough for guaranteed security, as far as surrounding buildings should be taken into account. Research has shown, that reinforcement of other buildings around the site perimeter creates preferred evacuation distance that reduces the intensity of casualties.

Research has shown that some environmental elements from CPTED checklist also meet counterterrorism principles. For instance, the idea that access to private and public space should be clearly defined.

According to FEMA guidelines (2003a, 2003b), previous researches in this field claiming that with clear zoning it is easier to achieve sufficient number of standoff distance, consequently it is easier to reinforce complex as a whole unit better than separate buildings. However, our analysis of case studies has shown that all recent terrorist attacks in Europe happened in districts without redistributed same functional buildings. These circumstances can draw conclusions that dispersion of major buildings in different zones can create extra safety layer and may reduce an asset value of objects.

The research results pointed out that *site function* can also have a significant influence on terrorist's choices of attack place. A high percentage of discussed places have a presence of various entertainment spots, or they are a venue of public activities. These circumstances make an area the easier target as far as terrorist organizations are able to achieve highest number of casualties with a little effort.

Regarding the *elements of street network reorganization*, for all the analyzed cities and sites of terror attacks it is pointed out that streets with high global integration values are mostly turning into places of terrorists' choices. The findings synchronize with the research results for street network planning based on space syntax theory implemented by Hillier and Shu (1998); Hillier and Sahbaz (2009). It can be concluded that areas that can be accessed easily, with a various combination of road networks, that affects road integration value, should be turned into less accessible parts of the city with complex way of organizing road networks.

Conclusions

Atlas R.L. 21st Century Security and CPTED :Designing for Critical Infrastructure Protection and Crime Prevention. CRC Press Taylor&Francis Group; 2013. <https://doi.org/10.1201/b15046>

Bjorgo T., Horgan J. Leaving Terrorism behind :Individual and Collective Disengagement. Routledge, Taylor&Francis; 2009.

Chidiebere Obi O., Ukaulor C.S. The moral questions on the religious basis for terrorism. International

Journal of Humanities and Social Science Invention, 2016; 5(4): 21-25.

Coaffee J., Boshier L. Integration Counter-Terrorist Resilience into Sustainability. Proceedings of the ICE: Urban Design and planning, 161. Loughborough Institution of Civil Engineering; 2008. 75-83.

Coaffee J. Terrorism, Risk and the Global City Towards Urban Resilience. Ashgate Publishing Company; 2009.

References

FEMA. Risk Management Series: Reference Manual to Mitigate Potential Terrorist Attacks Against Buildings, Providing Protection to People and Buildings; 2003a.

FEMA. Risk Management Series: Primer for Design of Commercial Buildings to Mitigate Terrorist Attacks; 2003b.

Hillier B., Sahbaz O. Crime and urban design: an evidence-based approach. In: Cooper R., Evans G., Boycko C. (Eds.). *Designing sustainable cities*. Singapore: Wiley-Blackwell; 2009: 163-186.

Hillier B., Shu S. Crime and urban layout: the need for evidence. Home Office Crime Prevention College, Easingwold; 1998.

Hogan J. *Walking Away from Terrorism: Accounts of disengagement from radical and extremist movements*. Routledge, Taylor&Francis Group; 2009.

Horgan J. *The Psychology of Terrorism*. Routledge, Taylor&Francis Group; 2014.

Howard R., Hoffman B. *Terrorism and Counterterrorism: Understanding the New Security Environment*. McGraw Hill Education; 2011.

Glaeser E.L., Shapiro J.M. *Cities and Warfare: The Impact of Terrorism on Urban Form*. Urban Economics Symposium on terrorism and the future of cities. December 2011. Discussion paper No 1942.

Godschalk D.R. *Urban Hazard Mitigation: Creating Resilient Cities*. American Society of Civil Engineers, 2003; 4(3) August: 136-143.

Lutz J.M. *Global Terrorism*. Routledge, Third edition; 2013.

Purpura P.P. *Terrorism and Homeland Security*. Butterworth-Heinemann; 2015.

Rothrock S.E. *Antiterrorism design and Public Safety: Reconciling CPTED with the Post_9/11 city*. Department of urban Studies and Planning at the Massachusetts Institute of Technology; June 2010. 97-102.

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