KAUNAS UNIVERSITY OF TECHNOLOGY

CIVIL ENGINEERING AND ARCHITECTURE FACULTY

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URBAN PLANNING AND DESIGN FOR TERRORISM RESILIENT CITIES

Master degree final project

Supervisor

Assoc. prof. dr. Irina Matijosaitiene

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KAUNAS 2017

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Architecture (621K10001)

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ANNOTATION

The lack of researches, concentrating on identifying urban features that can be associated with target selection by terrorists, determined thesis overriding question and goal, identify environmental security design elements, as well as spatial urban structures that can possible influence choice of places for terror attacks. To accomplish main goal, some prerequisite goals have been taken into account.

Initially, a brief history of terrorism and anti-terrorism design with number of examples and cases have been analyzed and assessed, where some sophisticated security design principles have been highlighted. For humanizing ant-terrorism design elements, crime prevention strategies have been explored, ending with a basic principle of urban and civic design.

Second Chapter of a thesis, researches environmental design factors and spatial urban structures that may influence the choice of places for terror attacks. Findings have reviled the chance of terror attack is high when 'site has a direct access to the main street'; when 'there are multiple entrances and exits to and from the site'; when 'site is well-used'; when 'public and private activities are separated'; when 'many same functional buildings are redistributed in a surrounding area'; when 'site has a direct access to the city center'. On the contrary, chance of terror attack is low when 'vehicle access point to the building is minimalized'; when 'medical institution is presented nearby the site' when 'Access to private and public space is clearly defined'. Research also pointed out that, globally integrated roads turning sites into a vulnerable and attractive target for terrorists.

Final Chapter of thesis, describes experimental project that has a theoretical, as well as field research results background, implemented into Tbilisi railway station and its surrounded site. Proposed design solutions show that security design can be transparent or in better case even invisible to public eyes. A thesis proposes that cooperation between security design and good urban design will turn existing railway station into a desirable and at the same time safe public space for the city.

KEYWORDS: Terrorism; Anti-terrorism design; Counterterrorism; CPTED; Crime prevention; Environmental Criminology; Urban planning; Civic Design; 'Invisible Security'; Space Syntax.

GLOSSARY OF KEY TERMS

Continues surveillance   The process of continues observation of a place, person (suspect) with help of technological devises. For instance, with CCTV cameras.

Cul-de-sac roads   The street with dead-end.

Correlation   A bilateral relation of two or more things, objects, elements and etc.

CPTED   Crime Prevention Through Environmental Design.

Dependent variable   Dependent variable, relays on independent variable. "(It is) what you measure in the experiment and what is affected during experiment" (NC State University).

FEMA   Federal Emergency Management Agency

Independent variable   The variable that can be controlled. "It is usually what you think will affect the dependent variable" (NC State University).

NCTCO   National Counter Terrorism Security Office.

Natural surveillance   The process of continues observation of a place, person (suspect) by people itself. For instance, by police forces or by residents.

Regression analysis   A statistical process of analysing relation between variables. It comprises various techniques and methods for estimating different variables (Wikipedia).

Space syntax(SS)   A term that comprises various theories and techniques in search on analysing spatial urban structures (Wikipedia).

Standoff distance	A security measurement for distance between vulnerable target object and potential threat.
SPSS	Statistical Package for Social Sciences.
Variable	"A characteristic, number, or quantity that increases or decreases over time, or takes different values in different situations" (Business Dictionary).
'eyes on the street' theory	Jane Jacobs theory, that tries to prove that populated sites are less likely affected by criminal activities with help of natural surveillance. (Jacobs, 1961)

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INTRODUCTION

A frequency of terrorism cases in a spatial configuration that strongly affects urban forms, as well as architecture sustainability, leads to death of a vast number of civilians following sense of insecurity, has highlighted a new obstacle for urban planners and architects, planning cities for meeting new standards of security against natural as well as manmade disasters.

According to some scholars, "contemporary security as a concept, practice and commodity is undergoing a rescaling, deterritorialization and reterritorialization, with previously international security concerns penetrating all levels of governance. Security is becoming more civic, urban, domestic, and personal: security is coming home" (Coaffee and Wood, 2006).

The importance of security is also determined by a significant number of recent terror attacks and mass violence that has had a disastrous impact on existing urban forms. The venue of terror attacks has moved from developing to developed countries that has already experienced number of attacks in a last few decades. According to this fact, insecurity has turned into a harmful hazard for most European cities. Existing urban polices in most cases do not meet security standards and guidelines for all the countries in the world (Matijosaitiene, Petriashvili 2017). Necessity of implementation of new environmental standards, as well as equipping major buildings in a high-risk urban area with elements against manmade disasters, has turned into essential factor for 21st century design. Some scholars claim that, "terrorism is becoming more local and (that) civilian's targets are being threatened by acts of mass violence" (Coaffee, 2009), whereas in fact, nowadays, urban planners are not very familiar with principles of security design. In addition, there is no significant attempts of cooperation between planners, municipality, governmental, regional structures as well as civilians for planning secured and pleasant environment.

Actuality and relevance of the field of security and anti-terrorism design is vivid after looking through cities as products of a security design. Furthermore, disastrous impact on urban forms, caused by terror attacks, as well as anti-terrorism design strategies, arising various social issues, outlined a significance and relevance of carrying out a deep research for farther investigating anti-terrorism design principles.

For highlighting necessity of security, the thesis starts with analysing medieval 'fortressed' cities, ending with urbanized, contemporary capitals. "Historically, the link between cities and mass violence is strong and complex" (Glaeser and Shapiro, 2001). Consequently, medieval fortresses had

been erected in order to create a safe 'harbor effect'(Glaeser and Shapiro, 2001). It is worth to mention that "violence (makes) travel difficult and increases the advantage of proximity" (Glaeser and Shapiro, 2001). Urban sprawl can be understood as one of the main determinant factor for 21st century city development, leading to urban clusters, isolated from city cores and developing independently. These circumstances, make it harder to fortify contemporary cities inside a "medieval fortresses". Although, some scholars state that it is better to be in a city than outside the borders of the town, as far as the role of city is to protect its residents against any violence activities (Glaeser and Shapiro, 2001), as for Pirenne, he sees origins of European cities in "fortified cities, erected by the feudal princes to provide shelter for their men" (Pirenne, 1936). Meanwhile, Bloch points out that "disorders of the early middle ages had in many cases induced men to draw nearer to each other" (Bloch, 1961). Nowadays a significance of 'invisible' security implementation has been outlined in many anti-terrorism design strategies. 'London Ring of the steel', the Great Britain solution of downtown surveillance is one of those. However, this excellent example of 'experimental traffic scheme' has its cons. A project faces up some social problems. While a visible police force prove protection against any violence actions, "it can also unintentionally frighten civilians away from downtowns" (Rothrock, 2010). Taking into consideration social aspects and the necessity of 'invisible' security, some scholars have argued the importance of the increased consideration of aesthetics in anti-terrorism and security design. To make matters worse, according to Blieker while security threats are becoming complex, our understanding and methods of providing security for city dwellers are out of date (Bleiker 2006).

As has been discussed before, topic has a historical background. Number of theoretical, social, and practical issues remain unobserved. This circumstance, highlights the relevance of investigating and solving security and anti-terrorism design issues to better suit 21st century urban patterns.

Main goal of a thesis is to identify environmental elements and urban design features that can be a potential determinant factor for choosing a specific site for terror attack, while avoiding others. Following this, thesis work aims to develop aesthetically pleasant experimental design solutions for terrorism resilient cities.

Main tasks of a thesis work are following:

1) identify high risk urban areas that are more likely turning into venues of terror attacks;
2) carry out analysis for identifying environmental features that could be a determinant factor for choosing particular area for attacks while avoiding others and draw prognoses for

identifying major variables (urban features) that will therefore provide some insights on the future analysis of terrorism targets, through urban planning factors.

3) identify spatial urban structures that can have a potential impact on site's vulnerability rate;

4) develop conceptual approach to the issue, while proving that consideration of anti-terrorism in relation of CPTED, civic and urban design principles, will lead to aesthetically pleasant, accessible, and safe environmental for site users.

5) check findings reasonableness with experimental design project of Tbilisi Railway station while implementing guidelines and principles, acquired from literature analysis related to Anti-terrorism design, CPTED, urban and civic design principles as well as from field research.

Research Objects for first part of empirical field research (questioner based research) are cities, that has recently been venues of terror attacks. Decision was made on sites, affected by suicide bombing, mass shooting, and car bombing. Research objects are following:

- Brussel (Maalbeek station);
- Liege (Saint lambert Square);
- Oslo (Governmental headquarter);
- Paris (Stadium of France "Stade de France");
- Paris (Boulvard Voltaire);
- Volgograd (Trolleybus);
- Diyarbakir (Governmental offices);
- Stockholm (City Conference hall);
- Ankara (Central railway station; Bus stop, Military headquarter);
- Ankara (Bus stop);
- Ankara (Military headquarter);
- Istanbul (Istiklal avenue);
- Istanbul (Sultan Ahmet district);
- Tel-Av-Iv (Small businesses).

According to characteristic of questioner based research, some sites without terror attacks (in same cities, presented above) has also taken into account.

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Second half of a research part, aims to carry out a large-scale territory analysis for cities, recently been affected by terror attacks. Selection was made on following sites:

- Ankara 2015, October (G. Mustafa Kemal boulevard);
- Ankara 2016, February (Turkish military headquarter);
- Ankara 2016, March (Ataturk boulevard);
- Brussels 2016 (Maelbeek Metro station);
- Istanbul 2016 (Istiklal avenue);
- Tel-Av-Iv 2016 (Dizengoff street).

Turning into a thesis *target object*. In order to implement and tests findings reasonableness from previous researches, a real problematic urban area, Tbilisi central railway station and its surrounding territory has been selected. A chosen site is located in Tbilisi, a capital city of Georgia. Selected urban complex, comprises some valuable public buildings, residential areas, shopping centers, museum, main public transport stops and etc.

There have been various *methods* and relevant *tools* used in search of developing thesis work, broadening knowledge in the field of security design, experimenting hypotheses with help of a field research and implementing findings into experimental project.

First part of a thesis, comprising reviewing literature with help of analysing widely-studied and researched papers, books, conferences, and lectures, related to anti-terrorism design CPTED, urban and civic design principles. As a main tool of this chapter could be foreseen various researches, books and articles with related topics. Federal Emergency Management Agency guidelines and RIBA anti-terrorism design principles are foreseen as main confessed references for thesis work while talking about anti-terrorism design principles.

The main part of a thesis is empirical field research on environmental design features that could be a possible determinant factor for turning a specific area into venue of terror attacks. In order to acquire precise results, research has been carried out in two ways. For identifying specific urban elements on a site scale, 'Yes/No' questioner has been developed based on CPTED checklist and with considering FEMA guidelines for anti-terrorism design principles. The information for filling in a questioner, has been obtained from aerial pictures of specific sites. Tool, that has been used for acquiring necessary data, is the following: Google Earth Pro for identifying existing program on sites, as well as various articles, from which relevant information about attacks has been gathered. In

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the end, SPSS software was implemented for identifying results from 'Yes/No' questioner, find correlation between urban elements, highlight variables with descriptive statistics and draw prognoses for experimental project design. Correlation analysis is used to identify relations between terror attack and urban elements, and automatic regression is used to make the prediction model for terror attacks

As for the second part of a field research that aims to investigate spatial features with help of site's larger scale analysis. Research has carried out with help of space syntax method (SS). As a research tool, DepthMap software is used for analysing following site attributes: integration, choice, connectivity, and mean depth of different areas. Methods will be discussed further in Chapter 2 of a thesis work.

Experimental project is the last phase of a thesis. It aims to integrate various tools and skills acquired from literature analysis related to terrorism, CPTED , urban design and civic design principles and real experiences from cities affected by terror attacks. In other words, experimental design considers findings from hypothetical model developed by literature review as well as from empirical research conceptual model for identifying urban features that have a possible relation with terror attacks.

Methods that has been used for developing experimental project for terrorism resilient cities are various. Thesis used space syntax method, in order to identify most vulnerable target objects in Tbilisi. As for acquiring information for site analysis, research used various sources, such are: National Statistics Office of Georgia (Geostat), Tbilisi Transport Company, Tbilisi City hall and National Archives of Georgia.

Turning into a *Structure of a Master Thesis,* the work is divided into three main chapters, **Chapter 1** gives a general overview on already existing principles and guidelines for anti-terrorism design, CPTED, urban and civic design, analyzed by various scholars. Consequently, it comprises three sections. First section, dedicates to anti-terrorism design, its history, principles, and strategies. Moreover, this part highlights the importance of 'invisible' security, as well as the necessity of cooperation between different institutions with civilians who are actually users of the space. Section 2 suggests an overview on crime prevention through environmental design (CPTED) strategies. Section 3 describes the process of placemaking, and highlights important elements that in the end will irreversible create a desirable place for site users. This section, outlines the importance of

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cooperating between citizens, who directly affected by the problem, urban planners, who need to solve the problem, governmental organizations, that need to see the problem.

In the end of the chapter a hypothetical model is described, that is therefore a theoretical result of literature review.

Chapter 2, describes the process of empirical research in search of identifying environmental features and spatial urban structures that can be determinant factors for turning sites into vulnerable targets for terrorists. First section of the chapter, clarifies field research methodology and analyses of selected sites for carrying out a research. Second section describes the process of evaluating site specific features with help of CPTED checklist questioner, as for third section, it comprises process of syntactical analysis of sites, affected by terror attacks and its results. Forth section, gives recommendations and building up prognoses model for some variables (environmental features). In the end of this chapter a conceptual model and conclusions are formed.

Chapter 3 is a report of experimental project design process and its results. It starts with describing well-augmented design object selection. This chapter comprises four sections. First section describes factors influencing design process; a qualitative research on site existing situation by analysing mobility, community context, urban life, shopping, parking on the site, and etc. Second section is related to quantitative as well as qualitative research necessary for design. In this section, design project boundaries are outlined. Third section draws strategical approaches for organizing railway station site in search of turning it into less vulnerable target for any possible attacks. As for final section, it describes the process of a design.

Thesis ends with whole work conclusions.

Intention of a thesis work, is to encourage urban and city planners, designers, and architects to consider safety measures in their initial projects, as far as it is much easier to mitigate and deter potential risk in a basic stage of design process.

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CHAPTER 1

Literature review on security design and placemaking

1.1 Terrorism in Urban Design practice

1.1.1. History, definition of terrorism and, city as a product of security design

Starting with explaining "The term "Terror", (that) comes from the Latin word "Terrere", which means "Frighten "or "tremble" The definition of terrorism varies over time and among agencies." (Matusitz, 2013) "It has also been described variously as both tactic and strategy, a crime and a holy duty" (Arowolo, 2013). According to Jeffrey studies, there are more than 212 definitions of terrorism exist across the world. (Jeffrey 2003) Consequently, thesis will use universally accepted definition: "Terrorism is the use of violence to create fear for political, religious, or ideological reasons" (International terrorism and security research). "The terror is intentionally aimed at noncombatant targets such as civilians or iconic symbols" and the objects that are valuable for country or nation in search of achieving the greatest attention from international publicity (Matusitz, 2013).

According to Zalman: "the history of terrorism is as old as human's willingness to use violence to affect politics" (Zalman 2016). It is relevant to mention that the first fact of terrorism dates back to 1st century AD. and associated with Zealots of Judea (Sicari), a politically motivated Jewish group, that aimed to murder enemies in order to push aside their Roman ruler from Judea. (Zalman 2016). As for modern terrorism, it has started in 1793 by Maximilien Robespierre, following the French revolution. His main motives were to transform monarchy to liberal democracy. Consequently, in 18th century, it was quite common to use terrorism as a violent tool against existing political regime.

Another refractive era in terrorism history starts in the middle of 20th century with the name on non-state terrorism influenced by the ideologies of nationalism and communism. In doing so, terrorist organizations have spread all over the world. During this time, suicide bombing and other tactics for achieving their goals were quite popular.

Terrorism, has turned more global only in the late of 20th century, when hijacking becomes a popular tactic of attack. This can be clarified by number of cases. For instance: an attack on El Al flight and 1983the bombing of a Pan Am flight by Liberation of Palestine in 1963. Among other terrifying events of this period 1972 Munich Olympics massacre, a politically motivated attack could be understood as a successful achievement of Palestinian terrorists that followed with international attention to their national causes. According to Naftali, Munich case was the main

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determinant factor that "the term counterterrorism and international terrorism formally entered the Washington political lexicon." (Naftali 2005) As for 21st century, terrorism acquired other motivations rather than politics.

Throughout centuries, cities have been formed in a way, to provide safety and security to its dwellers. Although, it has been achieved in different ways and methods. Consequently, it is relevant to state that medieval cities pattern had been mainly a product of safety, created by citizens itself. According to this, it is not a surprising fact, that the "most important, interaction between warfare and urban development is that historically cities have provided protection against land-based attackers. Cities have the duel advantages of large numbers and walls and thus, holding the size of the attack constant, it is much better to be in a city than alone in the hinterland" (Glaeser and Shapiro 2001). A clarification of this principle could be seen in medieval cities and settlements urban patterns. City inside a barrier that was presented by strong fortifications, a tactic decision on location of settlements on hills, on high mountains, cities surrounded by the moat, and etc. Inside the city, vulnerable architectural objects like castles were surrounded by walls or moats as protective elements. A significant fact of medieval city planning that can be seen in modern secured city patterns, was the fact that "irregular pattern in planning was devised to confuse enemies, as enemies were unfamiliar with town" (Gutjahr, 1999). A relevant example here could be city Mount St. Michele in France, that was enclosed within a protective wall and water surrounded the whole complex. However, example of city of Rome should be mentioned as an illustration of how violence directly impacted on urban forms in fortified medieval cities. After numerous attacks of Visigoth leader Alaric I, the population of Rome has dropped over 1 million in the year 210 to approximately 35 000 at the beginning of the middle ages (World Population Review). "Continuing attacks to the city has shown that living outside the Rome was safer than inside the city itself "(Glaeser and Shaparo, 2002).

Turning into cities from middle ages (12-13th centuries), when population grew immensely city still kept on developing inside a fortified wall and filling in open spaces. This circumstance caused number of issues from which most common problem was lack of hygiene. "The walled cities represented protection from direct assault at the price of corporate interference on the pettiest levels, but once a townsman left the city walls, was at the mercy of often violence in the countryside" (Guelph University, bibliography The Medieval City). this was mainly caused by the lack of polices to defend citizens outside protected city walls. Consequently, it is relevant to state that one of the main attractions of city centers (major city cores, remains from middle ages) is that, they provide a

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safer environment and are better equipped to defend themselves. For defending this statement some scholars argued that "the power of massed numbers in itself gave the city a superiority over the thinly populated widely scattered villages, and served as an incentive to farther growth" (Mumford, 1960). Although, high density in cities and a concentration of population on one specific areas tend to create an attractive target for mass violence with a significant result. "Consequently cities, have always been an attractive target of terrorists" (Matijosaitiene and Petriashvili, 2017).

If earlier cities used to have only valuable buildings protected against any violence, medieval dwellings from 12-15th centuries foreseen as individual fortresses. However, in fact, first independent fortifications for particular houses have been found in Mestia municipality, located in country Georgia, dates back to 8-9th centuries. Each household has its own tower for protection against any possible attacks.

Turning into new era of city planning (16th-18th centuries),number of questions have arised: "Must the wall be torn down? Must the armor be removed? Or did the civilization have the capacity to continue growth from its own center and so to arrive without disintegration, at a wider synthesis?" (Mumford, 1961). It is vivid that with new era, new perceptions and new ideas of security has been developed and implemented into city planning. According to Ashworth, in Renaissance period, when warfare has become an important aspect to consider in planning cities, a necessity of urban defense has been introduced, highlighting ineffectiveness of medieval fortification (Asworth 1991) There was a statement that 14th century city fortifications, moats or cities situated on inaccessible hills were turning the sites more vulnerable. " (Mumford, 1961). According to this fact, "Renaissance urban design have become a matter of elaborate fortifications and city security have become a duty for military" (Wyly, 2012).

Following with, 19th century, city planners and architect's major duty was to deal with problems, such as fastest growing population, that on itself led to problems of public health. This circumstance caused changes in street width and building height regulations, however it was not related to security design. Meanwhile in American villages, locals used to build homes in the center of their land (first attempt of maximizing standoff distance). According to this "In the American west, property was much more secure than in medieval Europe" (Glaeser and Shaparo, 2002). Although, this should not be the only reason, there was number of factors. For instance, easy connection of rural areas to major cities with organized highways. In addition to this, better transportation made social interaction possible despite isolated location as well as the size of farmlands.

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A significant fact for this century could be a popularity of vast migration of workers from rural to urban areas. This circumstance led to large, dense population, having a direct impact on form of the cities and how cities are planned. "Dense cities lend themselves to having tall buildings, subway system and other planned infrastructure to support the population" (Giuseppe, 2012), this infrastructure itself required more protection against manmade disasters. According to Glaeser, technological revolution made a few chances for an individuals to achieve a great amount of causalities "Today, relatively few individuals can do a significant amount of harm to much larger group (Glaeser, Shapiro 2002) whereas in fact in the past a single warrior could do more than committee a suicide. However, number of examples mentioned in following chapters put Glaeser opinion under doubt.

To sum up we can deduce that cities will always be a target of mass violence. Larger cities are more desirable targets for terrorists as far as high density means that there is high concentration of resources that can be affected by violence (Glaeser and Shapiro, 2002). "In the past marauders, raiders, wars, and pillaging affected urban forms, nowadays it has given a new universal name - terrorism" (Giuseppe, 2013).

1.1.2. Impact of terrorism on urban forms and high risk urban areas

As far as it has been agreed that universal name of mass violence could be 'terrorism', it would be relevant to discuss terrorism as a social and physical impacts of 21st century cities. According to what has been mentioned before, it is right to point out that terrorism can have a significant impact on both human welfare, as well as specific countries economic prosperity.

Major impacts of terrorism can be classified in the following four categories:

- human impact: impacts on human's well-being (psychological, health);

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- economic impact: for carrying out rehabilitation processes;
- public confidence: impact on changes in public behavior;
- government functionality (Glaeser et al, 2001).

All the four factors have a strong relation with each other, if any of them fails all the rest will fail automatically.

A vivid example of how terror attack, affected psychological aspect of society, could be found in Norway. 'Regjeringskvartalet' a governmental headquarter in Oslo, has been attacked in 2011. Even though there was a lot of ideas of how to regain 'power 'and valuable properties of a districts, almost half of employees rejected returning to their working places. (Paizs, 2013)

"If this diversity seems obvious when you look at Regjeringskvartalet, this is not what the Norwegian people express when they talk about it. To them, this district formerly a symbol of power is now a wound in their History…The Government Quarter became a place of gathering and remembrance. Time seems to have stopped then and there." (Guillot, L. 2013)

Turning into a high risk urban areas, it has been widely agreed that a significant concentration of civilians in a small land turns the place into an attractive venue for terror attacks. However, "Current practices have stayed away from this form of thinking, as the geography of terrorism has widened and there are more potential targets through urban areas which were traditionally not targeted" (Coeffee, 2009). High risk urban areas can be created either by the importance of the place leading to crowded places or by the activities takes place in it (political, religious, transportation, touristic attraction, and etc.). British government has number of publications claiming the danger of international terrorist in public areas. HM government 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" (HM Government, 2010). According to HM government, crowded places include: transportation hubs, sport stadiums, pubs/clubs/bars, shopping centers/shopping streets, tourist attraction spots; cinemas/theatres, commercial centers, business centers. Crowded places can also comprise public realm such are parks and squares. Crowded places can be subdivided by its physical attributes: permanent and temporary places. Permanent places can be outdoor or indoor venues. As for temporary places, it can be temporary ticketed event venues or open access events like parades or street exhibitions (HM Government 2010). This statement can be clarified by significant British attacks history, 1975 bombing of London hotels and restaurants, 1991 Victoria station bombing following with 1992 bombing of London Bridge station, 2005 London

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subway bombing and 2007 an attempt to bomb popular nightclub. However, it is just a minor list of attacks that took place in one of the most developed European cities.

While listing potential targets for terrorists, governmental and military installations, embassies, and etc. are in most cases belong to different group, so called 'hard targets'. It has been proved that terrorists, in most cases avoid attacking 'fortified' objects and instead choosing 'soft targets' were the probable success of attack is quite high, following with a high number of causalities and international publicity accordingly. It is significant to be mentioned that so called 'soft' targets have rarely been a target for mass violence (Coaffee, 2009). However, technological innovation, and number of terror attacks has highlighted the need to put a greater emphasis on a range of traditional and nontraditional targets.

Mumbai attack in 2008 is a clear example of 'soft' target attack with a little effort and simple tactics. Another determinant of success in Mumbai attack was that, public transportation was easily accessed by terrorists, and a significant concentration of population in a Mumbai train station turned into an ideal killing zone. Even though Mumbai 2008 attack aimed on other targets groups (to kill foreigners), train station calculated more than third of the total deaths. (Jenkinson, 2009). After a Mumbai attack Brian Michel Jenkinson highlighted the idea of terrorist motives: "Terrorism will continue to focus on soft targets that offer high body counts and that have iconic value. Nationally and internationally recognized venues that offer ease of access, certainty of tactical success, and the opportunity to kill in quantity will guide target selection. Public spaces are inherently difficult to protect" (Jenkinson, 2009). Transportation facilities have always been an attractive target for aggressors, if city walls ensuring safety of city dwellers inside immense fortifications, commuting from one city to another was dangerous (Glaser, Shapiro, 2002). Same threats, but in different scales can be seen in contemporary urban environment. However, in some cases transportation instead of being a main target of attack has been used as a weapon of attacking something more valuable. A good illustration here could be 9/11 attack on New York world trade center by hijacking airplane.

It is quite common theoretically approved approach that if we devalue importance of places it is possible to avoid potential risks, it is a "process of making the site or building of little to no value or consequence" (FEMA, 2003). The main idea behind devaluing important buildings is that, there will be less chance to be targeted. (Pawley, 1998).

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1.1.3. Anti-terrorism design implementation, its pros and cons and impact on the built environment

It is inclined to believe that any design interaction in already adapted human habitats that on itself leads to dramatic environmental changes has always been a reason of evolution in human behaviors. Sometimes behaviors responded negatively and in a rare case positively. Ellin in her article *Fear and City Buildings* describes formation of fear caused by architecture itself and how this architecture is affecting characteristic features of the city. Ellin clams that "most of what was built after the war in both the United States and Western Europe: isolated towers, slabs and unending blocks in search of diminishing sense of fear…has destroyed the image of the city, apart from this the rising tide of fear has transformed most public areas into controlled and guarded places." (Elin. 2001) while "security features at some sites are expected to be (tedious) and obtrusive, at other sites invisible, security is required to help such defensive measures to become acceptable to the public" (Coaffee et al, 2006), whereas in fact some scholars state that "the main rule of security is to make target inconspicuous, so any uniqueness of appearance or under prominence in a building will immediately be ruled out" (Pawley 1998). Those attitudes toward architecture, without considering social aspects leads design to so called 'Architecture of Fear' (Ellin, 1997). Other part of researchers could give it another name such as 'visible security'(Coaffee, et al 2009), both of them can be understood as a problem as soon as they appear in urban forms. Consequently, implementing anti-terrorism design principles into contemporary urban landscape in a more sensitive way rises the importance and relevance of this thesis paper. Even though, anti-terrorism design guidelines are mainly concentrated on reinforcing buildings with blast resistant materials, changing the shape of architecture and its orientation, some scholars are all for the idea to use aesthetics while thinking less vulnerable urban environment (Blieker, 2006) as far as, "Obtrusive security robs a city of its soul" (Briggs, 2005).

It has been highlighted that the impact of anti-terrorism design on already planned environment relates as much to the psychological, as well as the physical aspects of the city and its inhabitants. Accordingly, instead of stating, that form follows function, in this case it is more relevant to say that form follows fear created by civilians formed into what we call security design. It has been stated that the main obstacle of achieving an adequate level of security in potential target buildings that will be both terror-resistant and at the same time aesthetically beautiful is a lack of people's

interaction in design. It is suggested to have a cooperation between people who design spaces with its users (Briggs, 2005).

According to the Briggs, an author of *invisible security: The impact of counter-terrorism on the build environment*, there are three main physical ways in which Anti-terrorism design impacts on a build environment:

- "The militarization of urban space through the use of physical security barriers;
- iconography;
- a process of decentralization" (Briggs 2005).

The *militarization of urban space* could be associated with ancient city planning and 'fortress architecture'. A good example here could be a Belfast city in the Northern Ireland, where access to the center was initially reinforced by concrete blockers and later by high metal gates known as 'ring of steel'. This term has been used again in 1990 to describe the security measurement for downtown London, that will be discussed as a good example of 'fortification' in following paragraphs. Belfast is an example of how fortifications and city walls affected civilian's behaviors. It is relevant to say that, visible security makes people feel unsecured, even though there is no reason to be frighten. "A highly visible security not only sends the message 'we take security seriously' it also says that 'we need to take security seriously" (Briggs, 2005) and direct 'victims' of this phrase is a psychology of city dwellers.

A vivid examples of how anti-terrorism design affects human behavior, can be found in the US, London embassy that is being described as 'the fortress in the square', evidences have shown that existing anti-terrorism and "security defenses of the building has offended 'aesthetical sensibility' of local residents, some of whom have moved away rather than living near a perceived terrorist target" (Coaffee et al, 2006). To support a negative idea, caused by turning buildings into fortresses, Jason Burke argues that " planning has been co-opted in the name of security through the construction of multilayer counter-terror defense that has had significant physical, social and economic impacts, it is argued that security measures in most cases detract from the aesthetic value of the street and reduce public accessibility around the site, while increasing the perceived vulnerability of neighborhood residences and business"(Burke 2008).

It is a vivid fact that, barriers, fortification, concrete walls cause the fear rather than the hope and confidence of American society (Coaffee et al, 2006). Unfortunately, most planners have wrong

impression about anti-terrorism architecture, this is the reason why "national capitals have become fortresses, city peppered with bollards, bunkers and barriers owing both to a lack of funding for anything nicer and a lack of strategic coordination between policymakers" (Benton-Short, 2007).

The end of Urban *iconography,* as a result of 9/11 events, the power and attractiveness of symbolic buildings have been highlighted and made it less popular among planners and clients to create another attractive target for terrorists, leading to "more sober-looking cities…less high-rise, less representative, less 'signature' fashion" development" (Marcus 2002).

However, some researchers think oppositely, like Coaffee. He thinks that there is just a little chance that our urban landscape will become less interesting after numerous attacks on world famous iconic buildings. For illustrating his claim, he outlines a re-development project of World Trade Center in NY. The complex is going to comprise buildings even taller than the twin towers (Coaffee 2003). In addition to that, a number of examples throughout the world reinforcing his statements. For instance, Rem Koolhaas 80-storey building in Beijing, and other world tallest buildings, that have been constructed or are still under construction (Waudhuysen and Abley, 2004).

City planners understand the importance of developing creative and iconic architecture. Consequently, with urban renewal and development processes, society has to face up to its fears. However, James Waudhuysen, a modern commentator states that it is possible for architects and planners to make something creative without creating ambitious buildings so as less vulnerable targets for probable terrorist attacks (Waudhuysen and Abley, 2004).

City sprawl and decentralization after bombing cities like Dresden and Tokyo, as well as nuclear attacks on Hiroshima and Nagasaki in 1945, demonstrated a destructive power that existed in the world, idea of city sprawl has become as strategy for number of planners. A pioneer of using decentralization of cities as a solution to avoid significant number of causalities is Tracey and Augur an American urban planners. Augur in his book *The Dispersal of Cities as a Defense Measure* argues that "dispersed pattern of small efficient cities, (that are) much more attuned to the needs of modern living, modern commerce and modern industry" should be developed in place of adding to the dense cities which he argued would make them "more inviting targets" (Augur, 1948). The idea behind Augurs statement is that, if major functional cores in cities are dispersed properly the use of a nuclear weapon won't have a disastrous impact on city life. In addition, it is inclined to believe that with the proper dispersal of industry and population, no single attack will be able to disturb

production in a specific area, making it less likely to be targeted. Moreover, it will be vividly more resilient (Bartolo, 2012).

Augur's new idea is establishing satellite town that is similar to Ebenezer Howard's Garden city concept. According to another planner, Donald Monson, he states that the idea of satellite towns is not enough and that the center of cities needed to be broken up to create a safer environment (Monson 1953). There ideas and plans also comprises implementing highway projects for a better connection between satellite towns. American urban pattern is a clear example of Augur's and Monson's ideas: increase number of highway is used as a defense tool for Americans. Car dependent American society can leave peacefully in a suburban area away from potential targets of terror attacks.

1.1.4. Security planning Trends for terror-resistant cities

Understanding security planning varies between countries and centuries. However, in a contemporary world, 'invisible' security is becoming more inevitable and more acceptable for civilians (Coaffee et al, 2009). It is relevant to mention that "successful places are safe, well maintained and well managed. Achieving this depends on managing the physical asset effectively and appropriately. With the right structures, people who live and use the place will be able to influence what happens there" (English partnership 2007). Surprisingly, some USA planning guidelines, issued in search of creating urban security by implementing and even promoting ideas such are: open spaces, accessibility, and iconographies in cities. A good example here could be FEMA's ideas on better perimeter security design:

- "providing an appropriate balance between the need to accommodate perimeter security for sensitive buildings and … the vitality of the public realm;
- providing security in the context of streetscape enhancement and public realm beautification, rather than as a separate or redundant system of components whose only purpose is security;
- expanding the palette of elements that can gracefully provide perimeter security in a manner that does not clutter the public realm, while avoiding the monotony of endless lines of jersey barriers or bollards, which only evoke defensiveness;

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- producing a coherent strategy for deploying specific families of streetscape and security elements in which priority is given to achieving aesthetic continuity along streets;
- providing perimeter security in a manner that does not impede the City's commerce and vitality, excessively restrict or impede operational use of sidewalks or pedestrian and vehicular mobility, nor impact the health of existing trees" (FEMA 430, 2007).

However, current security planning has a much larger focus, rather than just thinking about aesthetical appearance of security installations. This part of the paper will review security trends through maintaining aesthetical and characteristic outlook of the site. According to FEMA guidelines "Security solutions need to be very carefully planned to maintain the public amenities and aesthetic qualities in neighborhoods in which residents and visitors feel welcomed, comfortable, and safe" (Davis, 1992; FEMA 426, 2003).

1.1.4.1. Major site-specific security design principles

According to the fact that terrorism is a new phenomenon for most of countries in the world, it is not surprising, that not every country has its own security polices suitable for their urban character, while some countries do not make it public. Consequently, thesis will analyse site security guidelines on American and United Kingdom examples.

Starting with the 'four Ds' of antiterrorism design that has been designated by FEMA 426 reference manual:

"Deter: The process of making the target inaccessible or difficult to defeat with the weapon or tactic selected. It is usually accomplished at the site perimeter using highly visible electronic security systems, fencing, barriers, lighting, and security personnel; and in the building by securing;

Detect: The process of using intelligence sharing and security services response to monitor and identify the threat before it penetrates the site perimeter or building access points.

Deny: The process of minimizing or delaying the degree of site or building infrastructure damage or loss of life or protecting assets by designing or using infrastructure and equipment designed to withstand blast and chemimcal, biological, or raidiolagical effects.

Devalue: The process of making the site or building of little to no value or consequence, from the terrorists' perspective, such that an attack on the facility would not yield their desired result" (FEMA 430, 2003).

Deterrence can be achieved by physical barriers, special signs, lights, specially reinforced street furniture, and etc. "Security experts agree that deterrence is an essential component in physical security planning" (Peart, 2010), this tactic increases security by minimalizing the chance that criminal will select a particular site for violent activities. Owing to the fact that deterrence often leads to fortress image of the site, it requires a proper design implementations. While designing physical barriers against any possible threat, it is important to hide them from potential offenders sight in order to make it harder for terrorists to plan their attack in advance.

Implementing strategy of detection, allows security forces to identify a potential threat and react adequately before it penetrates into a vulnerable site. Detection is relatively depending on site design. Good site organization will make detection possible without any blocking lines or sights. Detection of site can be achieved by alarms, sensors, CCTV cameras and by police presence on the site. In order to organize area, it is crucially important to strongly define activities, takes place in it, as well as connection between various urban spots. The following activities could be included: organized parking's, eating places, shopping, and etc. As for connectors, they can be paths and routes for both vehicular and pedestrian movements. This Anti-terrorism strategy could be related to CPTED strategy of natural surveillance, that will be discussed in following chapter. For natural surveillance, it is important that vulnerable target is seen from every corner.

In order to achieve detection, it is crucially important to minimalize hidden spaces, also it is important to choose the type and placement of lighting, plantings and etc., not to block the surveillance by the guard or by the CCTV cameras on vulnerable objects. It should be mentioned that continuous surveillance is more successful, when the site layout has a minimum number of entry points.

Strategy of deny is more relevant on a building scale, as far as it comprising reinforcing building construction frame, as well as exterior to turn it into more blast resistance. The methods and ways of denying possible terrorist targets will not be developed in a following chapter as far as thesis is concentrated only on urban design rather than architecture and structure of buildings.

As for *devalue* it is an important strategy for redistributing threat value in a surrounding territory leading to less valuable, and less vulnerable sites. This principle will be implemented in experimental project, described in Chapter 3.

1.1.4.2.Anti-terrorism design guidelines for increasing security on the site

This sub-subparagraph will describe various anti-terrorism design strategies provided by FEMA risk management series. It is an undeniable fact that the most effective and sophisticated method of dealing with the blast explosive is extended distance between vulnerable object and its perimeter barriers. In another word, it is crucially important to increasing a standoff distance. Standoff distance is "the distance between a barrier and a protected building" (The National Capital Planning Commission, 2005). The main obstacle for planners, is the fact that already constructed buildings are impossible to be moved once situated. In this case increasing the distance between streets and vulnerable buildings can only be achieved by extending building yards or even sidewalks. Another solution suggested by FEMA guidelines could be closing off some streets for vehicles.

The importance of standoff distance has been shown by various studies on objects that strongly or partly affected by blast explosion. However, there is not a precisely approved standard of standoff distance, as far as it can be determined by various factors such are threat rate, size of expected explosive and even the acceptable level of damage can be taken into account.
In order to plan an adequate standoff distance for a specific target object, there are two main features that should be taken into considered: "Mandatory evacuation distance (distance, at which unreinforced building is able to withstand severe damage or collapse) … and preferred evacuation

distance (distance, where people are in danger of being injured or killed by items through by the explosive blasts)" (FEMA 452, 2013).

The idea of a mandatory evacuation as well as preferred evacuation distances by considering all important features, can be following (table 1):

Threat description	Mandatory evacuation distance	Preferred evacuation distance
Suicide vest	21 meters	366 meters
Suitcase bomb	34 meters	518 meters
Car bomb	98 meters	564 meters
Van	122 meters	732 meters
Track	195 meters	1159 meters

Table 1 Mandatory and preferred evacuation distances by means of different ways of explosion (Source: FEMA 426)

In case of high density in cities and not existence of sufficient standoff distances, protection measures can be accomplished by reinforcing not only target object, but also surrounding territory by taking adequate distance from potential target object. However, this radius can be varying.

A good illustration of necessity of standoff distance, can be a terror attack case in 1996 that affected Khobar tower complex building in Saudi Arabia and its surrounding site (figure 1).

Setback distance: **25 meters**   **52 meters**   **122 meters**

- 🟥 Very high damage, possible collapse
- 🟧 Unrepairable structural damage
- 🟩 Moderate, repairable damage
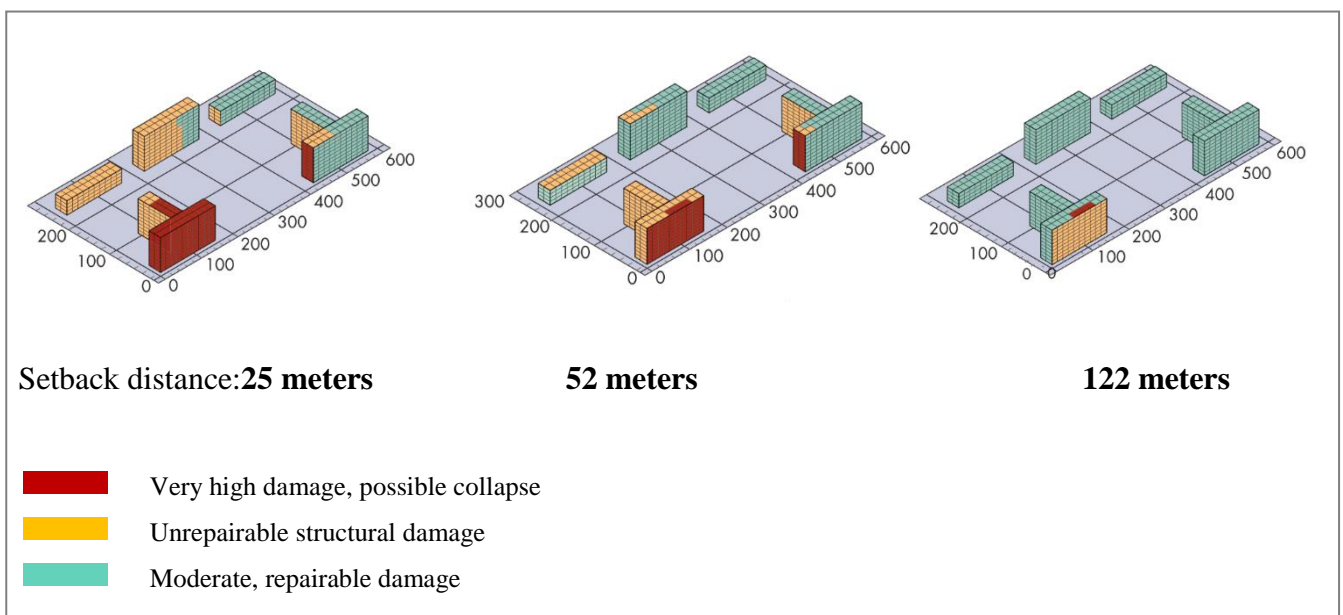
Figure 1 Illustration contrast of Khobar tower and its surrounding site in case of three different distances between the site and vulnerable building. Source: FEMS 426

Khobar tower case is a good illustration to what extent the blast can damage surrounding buildings. It also highlights the importance of standoff distance. Apart from standoff distance, building shape has a crucially important role in diminishing casualties caused by blast explosion. For instance, "U" or "L" shaped buildings, also strategies for building placement on the site, can rise or decrease its vulnerability (FEMA 426, 2003). As has been mentioned above, ideal location of an object is far away from the perimeter boundaries and property lines (FEMA 430, 2007). In addition to that, making plaza in front of main façade of the building and just leaving few setback distances on other sides of the building, can be beneficial, however it can lead to increase vulnerability rate of the rest 3 sides of the building. It has been outlined that site, surrounded with open space, is beneficial for its monitoring as well as for standoff distance value.

According to FEMA guidelines, site should have more than one access for evacuation, strongly controlled and defined exits and entry points, as well as strongly separated vehicle and pedestrian flows. (FEMA 430, 2007).

Turning into three layers of defense, anti-terrorism design strategy that arranges built and natural environment around vulnerable assets (figure 2).
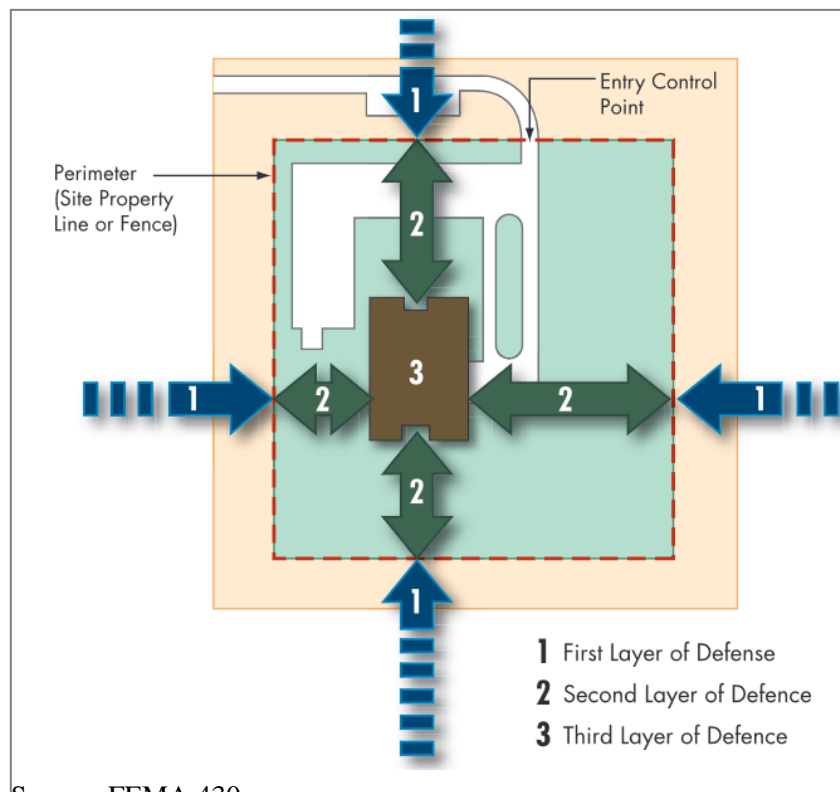
- First layer of defense, is an outer layer of the site also called as exterior community. In order to understand first layer of defense, it is important to have an in-depth knowledge of each type of activities and functions of buildings existing in the first layer. It can be analysed with help of GIS software as well as FEMA HAZUS tool (FEMA 430, 2007).

Figure 2 Site 3 layers of defense.

Source: FEMA 430

- Second layer of defense, is a space between the defended area and the potential vulnerable target. The main objectives of the second layer of defense is to prevent terrorists from

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interior areas. Second layer of defense can also be called as a standoff distance (FEMA 426, 2003) Wide standoff areas between a target and its perimeter defenses enables planners to perform target hardening improvements rapidly (FEMA 430, 2007)

- Third layer of defense refers to the protection of the asset itself. The main aim of Third layer of defense is to reinforce building's envelope and its structure. It is really hard to create third layer of defense on already planned building. Less standoff distance requires more mass and more steel construction for hardening the building, also thicker and stronger glass.

It is an undeniable fact that sometimes it is not possible to achieve relevant standoff distance, especially in downtowns where most buildings are occupying blocks completely, followed with high density and crowded places. In this case FEMA guidelines suggest to organize high valuable buildings together instead of dispersing important facilities, like this it is possible to achieve sufficient standoff distance (FEMA 430, 2007).

In search of hardening the site and turning so called 'soft' targets into 'hard' targets, following elements can be used for implementing into second and third layers of defense (FEMA 430, 2007) (picture 3; picture 4).

Permeable defense elements could be: bollards, trees, street furniture, large objects, and etc. As for impermeable elements they could be walls, terraces, raised planting beds, fences etc.

Bollards/planters (1) in most cases used as vehicle barriers. It prevents vehicles from passing but allows entrances for pedestrians and cyclists. It is usually made of steel. It is suggested to design bollards specifically for a particular project in order to be harmonized with existing materials, characteristics and forms of surrounding buildings. Those security elements can also have other functions, rather than just preventing vehicles from direct penetrations. For instance, they can be used as benches for sitting and etc. (FEMA 430, 2007).

Heavy objects and trees (2) can also be used in anti-terrorism design, sometimes instead of bollards or as an independent security design elements. "Heavy objects could be large sculptural objects, massive boulders, dense planting and trees" (FEMA 430, 2008). Those elements can be used in a similar way as bollards for preventing direct vehicular access to the asset. "Specially designed objects that serve practical and aesthetic purposes can be used as an effective barrier." (FEMA 430, 2008) For instance, IAMSTERDAM monument located next to the Rijksmuseum, is one of the most

touristic place, however, it is a heavy object intended to protect public spaces against high speed approaches by vehicles.

Water obstacles (3) is one of the oldest security design element, that is being widely used in the form of artificial or natural lakes, ponds, rivers, and fountains. Water can be an effective and beautiful choice for a barrier.

Jersey barriers (4) is not a good example of security design elements. They are not easily adaptable, as far as they come in standard length. In addition to that, they do not have aesthetically pleasant appearance.

Fences (5) are a traditional choice for security barriers. Compared to bollards they block entrances for both pedestrian and vehicle flows.

Reinforced street furniture and fixtures (6). According to FEMA, it is possible to reinforce street furniture and turn them into barriers. Those elements can be: hardened street furniture, planters, light standards, bus shelters, kiosks, and etc.

The NOGO barrier (7) is a barrier system, designed specifically for Wall Street area in New York City. It is partly a security device and partly a public art object. NOGO is combined with Turntable, it can also work as an active anti-ram system. (FEMA 430, 2007)

The Tiger Trap (8) combining sidewalks and planting systems. Its main aim is to diminish impact of force and at the same time maintain distinctive character of the area. Tiger Trap's major working principle is following: they can resist pedestrian load, however, vehicle load can collapse it.

(1)Cambridge Library bollards   (1) Rocks and Custom bollards as barrirs   (1) Planters

(2)low retaining wall and sculptural object as a barriers   (2) Monumental objecs as an obstacles

(3) American Embassy in London, water obstacle   (3)

Figure 3 Elements of Anti-terrorism design. Source: FEMA 430

(5)

(6) Reinfiorced benches

(7) NOGO barriers NY
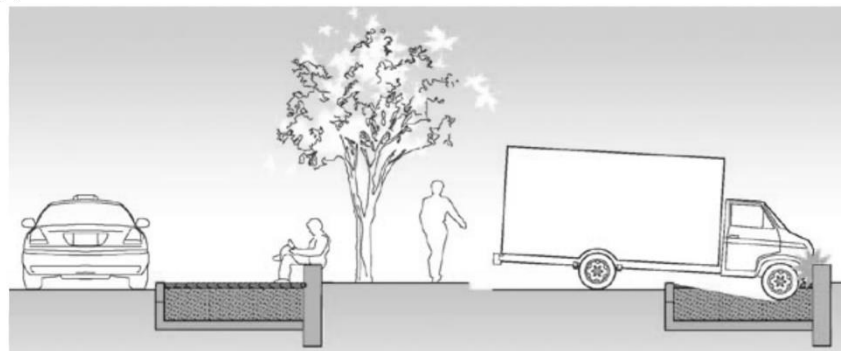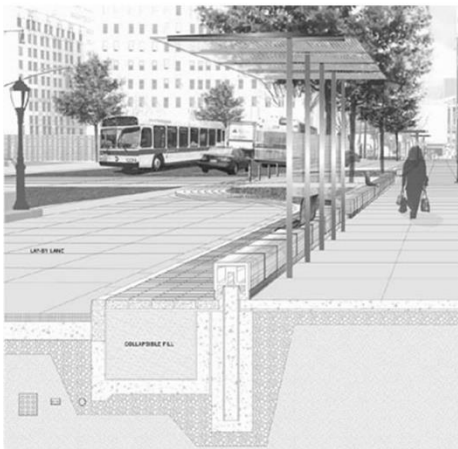
(8)TigerTraps

Figure 4 Elements of Anti-terrorism design. Source: FEMA 430, ASLA 2005 Professional Awards

There are numerous of other ways of reducing vehicular approach speed to major buildings, sometimes it can be achieved without physical barriers by "designing entry roads to the site and buildings so that they do not provide direct or straight-line access" (FEMA 430, 2007). In addition to that, indirect approaches to a building in combination with landscape architecture, can solve this problem. It is strongly suggested by FEMA 430, that gatehouses can be beneficial in case it is

impossible to have a dramatical changes on already planned infrastructure (FEMA 430, 2007). While talking about vehicles and potential threat from them, it is relevant to mention the importance of parking reorganization. According to FEMA guidelines, not adequately organized parking can turn the target into more vulnerable object against any possible threat. There are number of existing functional zones and elements that need a relevant consideration into design. Appropriate design and redistribution of parking, plazas and yards can lead to a successful anti-terrorism design and at the same time welcoming open spaces for a public realm.

The following already approved considerations are crucially important while carrying out a reinforcement processes on a potential vulnerable target. A good parking design should include the following:

- provide appropriate setback between parking and building, that needs protection;
- parking lots should have a clearly marked location separated from pedestrian flow;
- have a tactic location of public parking near the site or outside the stand-off zone;
- have a one-way circulation to facilitate in order to have an easy surveillance on vehicles;
- be surrounded with carefully chosen plantings in order not to distract natural surveillance on parking lots;
- it is important to clearly separate vehicular access points to the buildings from pedestrian flows;
- be equipped with CCTV cameras for better monitoring and continues surveillance. (FEMA 430, 2007).

As for underground parking, it need extra security measures, especially if it is located under the vulnerable building.

Three layers of defense are similar in arrangement of plazas. Additional space that is provided by plazas, enables effective second layer of defense to be achieved in an urban level. It allows designers to install interesting forms, intending maintaining the idea of plaza and at the same time improving security level.

A good example here could be a plaza of Minneapolis courthouse in United States, (figure 5) that is located on top of the garage roof. Design of plaza reflects its cultural and natural landscape while earth mounds make direct vehicular penetration almost impossible into the site.

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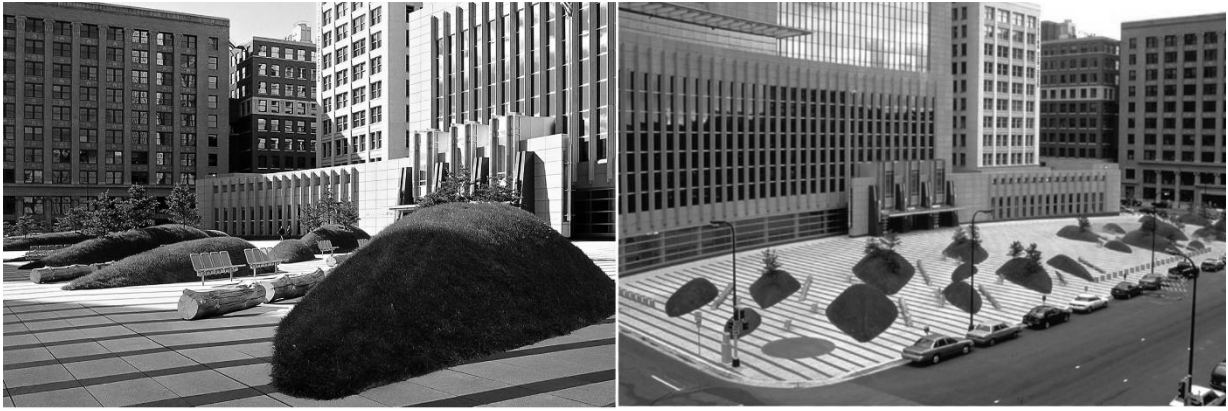
Picture 5. Minneapolis Courtyard plaza (Source: FEMA 430)

1.1.4.3.Aesthetics of Anti-terrorism design and 'invisible' security

Owing to the fact that equipping building with relevant security elements, in some cases may cause a dramatic change in overall outlook of the building, many scholars and researchers are trying to solve the problem of aesthetics in anti-terrorism design by outlining the importance of 'invisible' security. Consequently, while barricades and barriers used to define anti-terrorist urban landscape in 1990s in Great Britain, in recent years there have been a significant attempt to humanize security in cities, so "architects and urban planners begin to think more creatively about how they can hide security behind design features" (Briggs, 2005).

Coaffee, sees the necessity of aesthetical architecture while balancing security features. He calls this process 'urban renaissance' and claims that it is the main determinant of transformation our cities during the last 5-10 years (Coaffee 2003). Meanwhile, a good security design in downtowns provide decent number of places for social interaction. Accepting public realm in a vulnerable place is a foundation of 'Invisible' security.

"What landscape architects think about first when challenged with a perimeter security project is, well, the public realm, this is going to be something that is going to appear in the public realm, and at least we Americans typically think of the public realm as the floor of democracy. It's the place where we're free, and that means free will, but also freedom to move" (Cortnay 2011). Roger Cortnay's opinion, has been implemented into one of the most famous jersey barriers, in
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Washington monument, that has been a main topic of discussion. About five years ago it has been replaced by a decorative wall at the base of the hill, designed by landscape architect Laurie Olin. Tourists commonly treat it like a bench, but in reality, it designed for the purpose of stopping a truck (Badger, 2011). Another example could be new Emirates Stadium in North London with its anti-terrorism design element. It has been later recognized as a good example of new building site security design feature. Like 'IAmsterdam' 'ARSENAL' is spelled with concrete letters, preventing vehicle access, and meanwhile encourages public realm on the site (BBC, 2007; Coaffee and Bosher, 2008).

Other anti-terrorism features are possible to be even more invisible. For instance: turntables, tiger traps, flower pots as a bollard, CCTV cameras, and etc. "Technological development and design imperatives create security that is almost invisible to the or 'light touch'" (Coeffee and O'Hare, 2008), that will therefore bring aesthetics and access benefits to the site. However, it will rise some serious questions:

- "Who makes decisions and how are they monitored?
- Where does the power and authority to take such decisions lie?
- How will technologies be used in public and private spaces?
- What is the balance between civil design and security with regard to the 'war on terror'?" (Briggs, 2005).

Ruth Reed, president of the Royal Institute of British Architects, highlighted the importance of public realm while introducing 2010 counter-terrorism design guidelines: "It is important that our built environment continues to reflect that we are an open and inclusive society, and that in interpreting these new requirements our buildings do not convey that we are driven by security measures" (Reed, 2010).

According to Stephen Ward "While the protection of people must remain primary aim' of any kinds of design, it is vital that all alterations to our historic places are carefully considered and sensitively handled, if character, charm, and historic interest are not to be the first and, perhaps, the only victims of the threat" (Ward, 2004). It is relevant to mention that UK has number of legislations and policies protecting characteristic features of historical buildings while reinforcing them against any terror activities. Anti-terrorism design has two key impacts on protected zones: visual and physical. Due to the fact, that it is rather difficult to reinforce historical buildings against blast explosion, it is quite flexible to deal with this issue by putting the secure boundaries as far away from the building

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envelope as possible. Moreover, it is suggested to implement security measures to historic building exterior and inner structures. Nicely and adequately designed physical barriers, can prevent uncontrolled vehicular access to surrounding streets.

Another aesthetical issue could be, maintaining idea of public spaces and at the same time protecting them from possible threats. If we define public space as a 'social space' that is generally open and accessible to people of all levels, considering accessibility problem is crucially important in each level of anti-terrorism design. While talking about accessibility, we should distinguish accessibility by vehicles and by pedestrians. Contemporary urban defense design tries to organize traffic flow instead of abolishing movements of pedestrians on the streets.

According to number of scholars, security and insecurity can also be associated to the structure and organization of the road. Although Hillary and Sahbaz have argued that there are insufficient studies to form any conclusions regarding the impact of road network reorganization on crime rate (Hillary, and Sahbaz 2009), later on with other researchers (Hillier and Shu (1998)Shu (2000)Hillier (2004) agree that "being located on a development with high levels of permeability connectivity (and) through-movement reduces the risk of crime." In contrast, number of scholars are having an opposite idea that this circumstance increases crime rather than decreases it (Bevis and Nutter (1977) Rubenstein et al (1980) Taylor and Gottfredson (1987) Van der Voordt and Van Wegen (1990) White (1990) Poyner and Webb (1991) Beavon et al (1994) Mirlees-Black et al (1998) Rengert and Hakim (1998) Hakim et al (2001) Taylor (2002) Nubani and Wineman (2005) Yang (2006) Armitage (2006))

According to unclear results, this consequence will be tested in Chapter 2 of this thesis, with another hypothesis that Being located on a cul-de-sac, or a development with low connectivity, reduces the risk of crime (Bevis and Nutter (1977) Johnson and Bowers (2010)), although urban planners think that cul-de-sac roads is not acceptable as far as it determines long journeys and turn some places harder to be accesses. Meanwhile some researcher state that "using street as an 'invisible' security tool for reducing crime can be achieved by closing this street itself" (Matthews (1992) Atlas and LeBlanc (1994) Newman (1995,1996) Lasley (1998) Zavoski et al (1999) Eck (2002))

Related to this topic, Dr. Rachel Armitage carried out interesting research. Her research main concentration was on street layout. She considered, that a specific street patterns, could be a determinant factor of site's vulnerability. After looking through crime statistics, Armitage, research pointed out that "Sinuous culs-de sac roads are safer than those with a linear layout." (Armitage,

2011) This finding has become significantly important for future researches as well as for this thesis work.

One of the most relevant design example that could have a firm relation with the idea of having a minor security implementation in major cities downtowns without affecting an overall image of the city, could be a sophisticated idea of defending London a capital of England against terror attacks. The idea is more likely associated with organizing road network in an appropriate manner.
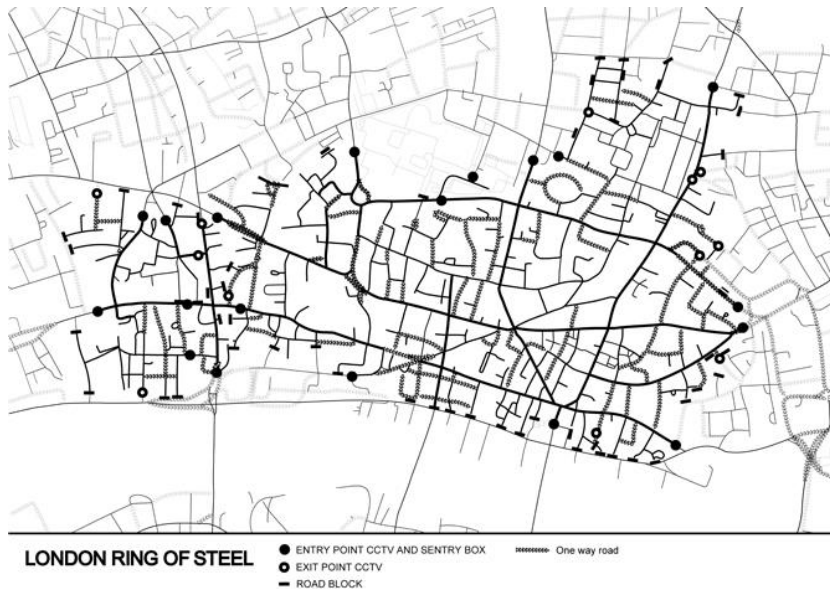
This approach can also be associated with 'fortress urbanism'. The ring of steal , instead of concrete barricades and road barriers uses contemporary defense systems such are: CCTV cameras and various environmental elements:

Picture 6 London Ring of the steel, experimental traffic scheme. Source: Harvard design magazine

boxes, bollards, one way systems street furniture and plantings for extra layer of defense. A significant fact about this principle is that, some unsafe activities are removed from streets and has maximized control on access points (picture 6). In doing so, in some streets 2 direction movements have been abolished. The way of organizing roads by "London Ring of the steel" gives a natural surveillance on the site. Only seven entrances have remained on the site and armed guards were disposed in each road checks. It is not a surprising fact that, another name of a 'London ring of the steel' is 'experimental traffic scheme.'

As for a good 'invisible' security example for small scaled site reinforcement, that will also be implemented in farther process of thesis development, could be Mies van der Rohe, Chicago federal center, built during the years of 1959-1974. The plaza next to the building is designed to serve as public communal space. Complex includes: farmers market, public gatherings and a large sculpture that can be understand as an identity of the place. In the past, the problem of the site was the lack of decent standoff distance, another problem that had been faced up with the project was to design building with open ground floor to provide easy access to visitors and to connect one street to another. (FEMA 430, 2007) As a result of security design implementation, first layer of defense is provided with bollards, granite blocks and benches that has been selected to harmonize with building architecture and materials. In order to avoid direct vehicular penetration from the street intersection, pedestrian lines have been reinforced with bollards system. As for second layer of defense, it has been achieved by plantings and various barrier systems that on itself gives the sense of public openness.

Alternative solution of wall- using as a bench for community purposes

Figure 7 Chicago center. Source FEMA 430

1.2. Place based crime prevention through environmental design (CPTED) principles and practices:

1.2.1. First and second-generation Crime Prevention Through Environmental Design (CPTED) definition and history;

Target hardening and anti-crime design was made popular through the movement known as crime prevention through environmental design. Compared to anti-terrorism design strategies, it is quite common that crime prevention through environmental design is widely implemented into very basic levels of planning. Crime prevention through environmental design (CPTED) is one of the most popular urban planning strategies in search of decreasing crime rates on the site. This strategy uses specific design features as a tool. Main aim of CPTED is to elude potential criminal activities that can make a change on the built environment (Lee et al, 2016). Idea of CPTED has a strong background of environmental psychology and its belief that human behavior can be determined and influenced by surrounding built environment (Cozens et al, 2005).

The term 'crime prevention through environmental design' first have been used by Ray Jeffery in 1977. As for Jane Jacobs book 'The Death and life of Great American Cities' is considered to be the origin of forming the idea of CPTED principles (Lee et al, 2016).

There are four key features that are strongly connection with any crime events, those are following:

- "a law;
- offender;
- target;
- place" (Brantingham and Brantingham, 1981).

It is an undeniable fact that there are much possibilities to analyse places rather than offender's behavior or law and victims. From the beginning of 19th century, it has been stated that some places are more vulnerable for criminal activities compared to others, and this difference was mainly caused by differences in urban features, provided by different sites (Cozens et al, 2005) According to a highlighted importance of place in crime prevention principles, a widely accepted description of CPTED could be: "the proper design and effective use of the built environment (that) can lead to a

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reduction in the fear and incidence of crime, and an improvement in the quality of life" (Crowe, 2000).

A lot of researchers and scholars started to investigate relationship between human behavior and its environment, as far as "It is fairly obvious that the form of urban environment affects the distribution and circulation patterns of its inhabitants. People generally walk along sidewalks or streets but seldom traverse blocks. People follow designated paths in parks and gardens; they tend to wait for the bus at the bus station and not along its route; and, they enter their homes through the front or back door. Changes in the design of the physical environment will, therefore, affect their circulation behavior and the frequency of meeting and seeing other people"(Angel, 1968). Consequently, it is quite possible to control human's behavior in space and in some cases even use them as a tool for preventing crime. For instance, Angel in his paper defines the idea of controlling pedestrian density and flows. He states that with help of moving density from areas with high values of criminal activities, will diminish number of casualties. According to Angel's theory it can be achieved by concentrating same functional businesses in one spot and providing safe parking for every spot.

In the late 1960s and early 1970s, architect Oscar Newman carried out a study about large public housing estates in St Louis and New York. His publication, *Defensible Space: Crime Prevention Through Urban Design*, reinforced the idea about a strong connection between crime and environment. Newman developed the concept of 'defensible space', which he viewed as a "range of mechanisms—real and symbolic barriers... (and) improved opportunities for surveillance- that combine to bring the environment under the control of its residents" (Newman, 1972). Another key point that has been highlighted by Newman in his book is that, 'defensible space' can be the one, were people are able to be a spectator of all events that takes place around them. Also, it is crucially important that people should be seen continually. In addition to that, it is also important, people to have a common will to report all criminal behaviors when it occurs. Newman claimed that it was an encouragement for people to control areas where they spend most of their time, and like so ensure the role of ownership. When civilians feel safe in their neighborhoods, they are getting more willing to be active and free to report any criminal activities that takes place in thein neighborhoods. Oscar Newman in 1972 highlighted key elements of CPTED:

- surveillance (ability to monitor activities on the site);
- territoriality (separation of public and private activities);

- image maintenance (the image of a place is an important factor in reducing opportunities for criminals);
- milieu (environmental land use. Selection of a secured site for a new development is important). (Newman, 1972)

According to Poyner, the attractiveness of Newman's idea was that "… His main aim was to find ways of changing the underlying structure of the environment so that it would not attract criminal behavior" (Poyner, 1983).

Another discipline that has a significant influence on CPTED development is environmental criminology. Even though Rey Jeffery was an inspiration of CPTED, he dedicates major part of his work to environmental criminology, rather than CPTED. According to Geographers Herbert and Hyde, environmental criminology tends to investigate vulnerable areas, where the possibility of occurring any criminal activities are high compared to less vulnerable areas (Herbert and Hyde 1985). Main difference between crime prevention through environmental design and environmental criminology is that, environmental criminology is more concentrated on human psychology and behaviors. As for CPTED, it is more concentrated on understand environmental features that could be a determinant factor of criminal behaviors (Crowe 1991).

Environmental criminology is based on 3 theories:

- Pattern Theory by Brantinghams;
- Routine Activity theory by Marcus Felson;
- Rational Choice theory by Ronald V. Clarke;

Environmental criminology influenced a formation of situational crime prevention. This new discipline is based on a philosophy of environmental criminology. Notwithstanding, those two disciplines has developed in a different direction. The idea of situational crime prevention is cooperation between police and community members in order to protect their neighborhoods. (Rothrock, 2010).

Before 1980s 'defensible' space design tools worked best in residential settings. However, after 80th, it has been observed that 'defensible' space theory was also efficient for institutional and commercial buildings. According to this, in search of improving 'defensible 'space strategies Newman and other researchers filled in CPTED features. Such are:

- the 'Broken Windows' theory by James Q. Wilson and George L. Kelling;
- 'the four dimensions of crime' theory by Patricia and Paul Brantingham;
- 'situational crime prevention' theory by Ronald Clark and Patricia Mayhew;

- criminologist Timothy Crowe developed his CPTED training programs;

In 1988 Timothy Crowe, published an article, uniting principles from 'Defensible Space', situational crime prevention and environmental criminology. He claims that CPTED is made up by combination of this fields. (T. Crowe 1988).

This initial step of dealing with any kinds of criminal activities in an urban form with help of physical attributes and adequate urban planning and design principles is united under an umbrella of movement, known as 1st generation of CPTED.

Turning into a second generation of CPTED that is inclined to believe an extension of 1st generation CPTED. It is a significant fact to be mentioned, that second generation is not replacing first generation principles. However, it adds first anti-crime design movement more social and cultural aspects in each neighborhood. 2nd generation CPTED, promotes considering design principles more on a neighborhood scale.

Except this definition, 2nd generation of CPTED could be a strategy that main idea is to defend places from criminal activities by preventing crime from growing inside neighborhoods (Saville and Cleveland, 1999). A good explanation of new CPTED movement could be following: "Second Generation CPTED recognizes the most valuable aspects of safe community lie not in structures of the brick and mortar type, but rather in structures of family, of thought and, most importantly of behavior" (Saville and Cleveland, 1999). 2nd generation of CPTED claims that it is possible to benefit from examining physical aspects and features of places and their relations to crime events, but is important to end up research on social aspects and neighborhoods. Consequently, it is not a surprising fact that, main task of 2nd generation CPTED is to:

- form a residential association;
- form a 'neighborhood watch';
- enhance social cohesion;

Those tasks are later implemented into creating principles and strategies for 2nd generation CPTED, described in a following subparagraph.

According to Saville and Cleveland research, the theory of 2nd generation CPTED could be comprising following:

1) 'human scale development', as far as size of the district and its density can consider the extent of social interactions. It is difficult to control your neighborhood and know all dwellers when there are almost 3000 households and when the schools have same number of

students. However, Cleveland and Saville agree on the fact that accomplishment of this theory mainly depends of culture and personal respect.

2) the density and variety of urban meeting places is very important as far as the lack of it will lead to empty spaces. Consequent, social interaction will become impossible. There is a high risk of undesirable activities, that will take place in urban meeting places. However, someone should take a responsibility to organize 'safe activities' in their neighborhoods. Those events should happen until people will experience so called 'neighborliness'. This theory is mainly associated with 1st generation CPTED strategy 'activity support'.

3) youth clubs are the places where local young generation can learn important things.

4) resident's participation is also associated with 1st generation CPTED idea of 'activity support'

5) resident's responsibility "have a direct influence on their expression of territoriality and defensible space" (Saville and Cleveland, 1999).

It is inclined to believe that 2nd generation CPTED enables its strategy to be more realistic for crime prevention. It is much more reliable strategy in search of changing offender's motives before committing a crime.

According to what have been mentioned before, we can conclude that, first generation of CPTED, ('First generation advanced') mainly focused on physical environment while second generation of CPTED focuses on social aspects of design.

1.2.2. First and second-generation crime prevention through environmental design (CPTED) Principles and strategies

There are five main principles of 1st generation of CPTED: natural surveillance, natural access control, territoriality, activity support, image maintenance. (Crime Prevention Through Environmental Design Guidebook). Some documents recognize six main principles of 1st generation of CPTED, adding 'target hardening' as a key strategy. According to Crowe's, it is very important

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that CPTED principles is understandable and practical for space users. Consequently, he offers remembering 3 'D' strategy: designation, definition, and design. 3 'D' strategy enables users to discover the purpose and design of a specific areas with a simple questioner (Crowe and Fennelly, 2000) (Figure 8).

1. DESIGNATION

- What is the designated purpose of this space?
- For what purpose was it originally intended?
- How well does the space support its current use or its intended use?
- Is there a conflict?

2. DEFINITION

- How is space defined?
- Is it clear who owns it?
- Where are its borders?
- Are there social or cultural definitions that affect how space is used?
- Are legal or administrative rules clearly set out and reinforced in policy?
- Are there signs?
- Is there conflict or confusion between purpose and definition?

3. DESIGN

- How well does the physical design support the intended function?
- How well does the physical design support the desired or accepted behaviours?
- Does the physical design conflict with or impede the productive use of the space or the proper functioning of the intended human activity?
- Is there confusion or conflict in the manner in which physical design is intended to control behaviour?

Figure 8 Space evaluation questioner according to Crowe's 3 'D' strategy. Source: Crime Prevention Through Environmental Design Guidebook

CPTED principle of natural surveillance is influenced by Jane Jacobs and her 'eye on the street' theory. As for, Oscar Newman and his research on 'defensible space', farther developed this idea. Newman with his research discovered, that hidden places are more likely turning into venues of criminal activities, compared to the once that can be observed by people. Also, he stated that buildings and community design (civic design) are main encouragement for natural surveillance. For natural surveillance on the site it is important to have open and visible gathering spaces. Consequently, during late hours site should be equipped with design features that ensures lighting in every spot of the area. Design should avoid hidden places. Inhabitants should have an

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opportunity to monitor activities that takes place in their neighborhood from their windows. Also, police presence on the site is crucially important for natural surveillance strategy.

The main idea behind the principle of 'access control' is "to keep a potential criminal out of the community and public spaces, through so-called 'safe activities" (Lee et al, 2016). This principle can be achieved by creating visible or invisible barriers. Newman discovered, that multiple escape routes can turn the area into a vulnerable place and not resistant to any criminal activities (Newman, 1972). For achieving natural access control on the site, it is important to consider following: using fences, lightings, various landscape elements, signage to clearly guide visitors to and from the site.

Territoriality was also developed as a CPTED key strategies by Jacobs and Newman. The concept of territoriality introduces idea of social networks, in another word, community networks and claims that it is more efficient than just police forces (Jacobs 1961). Territoriality strategy gives superiority to residents to better control their communities. Strategy of territoriality also considers the idea of a strong separation between public and private activities. In doing so it is important to encourage communications between neighbors with relevant design features. In addition to that, appropriate design should provide visible or invisible boundaries between public, semi-public and private zones. Moreover, businesses should be identified with wall signs.

Activity support can be achieved by implementing appropriate principles in an initial stage of design. Activity support encourages 'safe activities' on the site (Cozens et al, 2005). It is strongly believed, that detection of crime is much easier when site has a capacity to offer various activities to its users. Jacobs 'eye on the street' theory can be relevant for defining activity support strategy, she suggests, that streets and sidewalks with number of events and activities attracts people, that guarantees natural surveillance and easy detection of any potential crime events (Jacobs, 1961).

Image Maintenance (Site management) principle is associated with Philip Zimbardo's experiment, carried out in 1969 and a 'broken window' theory experimented by James Q. Wilson and George L. Kelling. Philip Zimbardo in his experiment used vehicles without license. He parked cars in Bronx and left intendedly. Inattentively left vehicle soon had turned into victims of vandalism. The inspiration of Zimbardo's experiment is Kelling's and Wilson's 'Broken window' theory. This theory states that, "once there is one window broken and left unattended, there will be more broken windows in the row" (Kelling and Wilson, 1982). To say in another word "the actual presence of disorder-related cues, negatively influenced the perception of crime-related problems" (Perkins et al,

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1992) For accomplishing maintenance strategy, it is important to some restrictions on some activities in common areas that can damage the image of neighborhood.

Uniting these five concepts, are considered as backbone of traditional CPTED strategies. In search of complete fulfillment of CPTED main principles, Crowe, a director of the National Crime Prevention Institute suggests nine strategies:

1. "provide clear border definition of controlled space.
2. provide clearly marked transitional zones, that indicates movement from public to semipublic   to private space.
3. relocate gathering areas to locations with natural surveillance and access control or locations away from the view of would-be offenders.
4. place safe activities in unsafe locations.
5. place unsafe activities in safe locations.
6. re-designate the use of space to provide natural barriers to conflicting activities.
7. improve scheduling of space.
8. redesign or revamp space to increase the perception of natural surveillance.
9. overcome distance and isolation through improved communications and design efficiencies" (Crowe, 1991).

As for second generation of CPTED, Saville and Cleveland's identified elements of a Dutch 2nd generation CPTED plan that they considered progressive. These elements are following:

- "the necessity of human-scale development
- the importance of urban meeting places
- establishment of youth clubs
- engaging residents to procure participatory support and encourage responsibility regarding maintenance and upkeep" (Saville and Cleveland, 1997).

The key principles of 2nd generation of CPTED are following: "neighborhood capacity, community culture, social cohesion and connectivity" (Saville and Cleveland, 2003).

Business/Neighborhood capacity in another word *social cohesion*, main aim is to give responsibilities to community residents, passersby, and neighborhood businesses to control all activities in their neighborhoods. This strategy can be achieved by social participation in organized

events, communication with other neighborhoods, creating groups in search of discussing neighborhood problems, their solutions, and etc.

Community culture is the way of developing common sense of neighborhood and its history. In order to achieve this strategy, it is important to promote the idea of gender and other minority group equality strategies. For instance, organize events that will highlight distinctive character of neighborhood, common public transport, that therefore connects neighborhoods, and etc.

Neighborhood threshold and *capacity* main aim is to serve some functions or support specific activities from neighborhood communities. This CPTED strategy highlights the importance of "economic and social stabilities that communities are dependent on" (Fisher and Lab, 2010) to not couse cause deterioration and abandonment of neighborhoods.

Connectivity ensures a strong links between communities and strengthening community bonds in businesses, and activities referring to community and neighborhoods. It suggests the idea of common public transport, that will therefore connect neighborhoods.

1.3. Placemaking Principles

1.3.1. Main urban design principles

According to the fact that the thesis work aims to promote a possibility of cooperation between fields such are CPTED, anti-terrorism design urban and civic design strategies, it is relevant to start defining urban design principles for placemaking.

"It is quite vivid, that downtowns in London in New York and other major cities are not just the products of anti-terrorism design or consideration of CPTED " (Rothrock, 2010) It is an undeniable fact that, anti-terrorism guidelines initial consideration in design can protect buildings from a disastrous impact on economy and human's health after terror attacks, as for CPTED it will regulate sense of safety among space users by implementing its strategies in a very initial stage of design. Although, this circumstance rises the necessity of optimizing both security design principles, in this case thesis work considers urban and environmental design as a tool for giving security design more aesthetical appearance. In other words, the aim of the work is to make a balance between security and appropriate usage of spaces.

Many urban designers, architects and architecture theorists have tried to identify major physical attributes that will later leads to a good public space. Whyte, Lynch with his book "Theory of Good City Form" or "The image of the city" Mackay, Colman, Gosling, and etc. tried to identify all the elements in urban design practice that will later ensures a desirable place for public realm. There are strongly defined and internationally accepted some key elements that will irreversible create a usable urban space (figure 9). The key attributes are divided into other elements, those are the following: sociability, uses and activities, comfort.
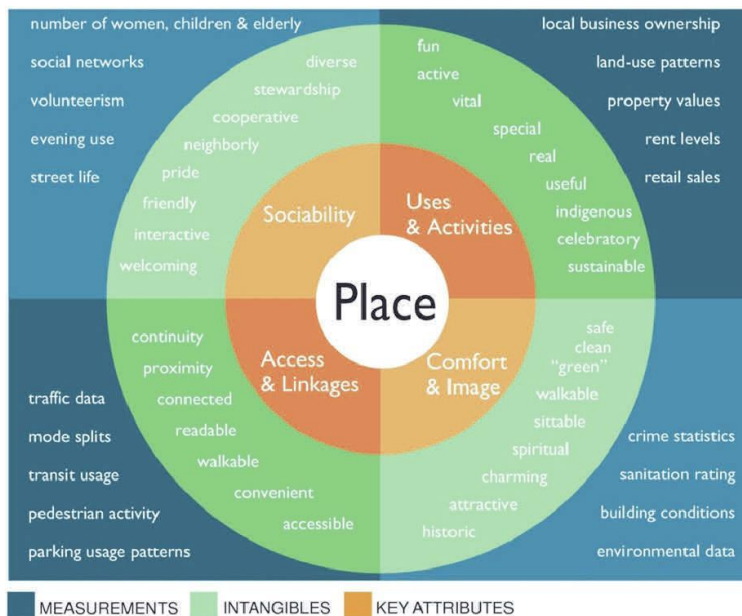
Figure 9 Diagram of placemaking principles, highlighting key attributes, intangible features, and measurements. Source: Project for Public Spaces;

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According to Project for Public Spaces "a successfulness of a particular place depends on the potential of space to become an icon of public space." (Project for Public Spaces, 2010) as well as accessibility to places.

It is an undeniable fact that good urban design creates places which maintain sustainable, attractive, and desirable environments, that people are willing to use. British Home Office highlights seven urban design main attributes that creates desirable places.

- "Character, place, with its own identity;
- Continuity and enclosure, a place where access for the public is clearly identified.
- Quality of the public realm, a place with a lot of attractive and successful areas accessible to the public.
- Easy of movement, a place that is easy to get through but where routes do not compromise security.
- Legibility, a place that has a clear image and is easy to understand.
- Adaptability, a place that is capable to change easily.
- Diversity, a place with a variety of activities for different aged groups and the choice for everyone." (HM Government, 2012)

There is number of other ideas about the major elements of urban design. Other scholars can highlight functionality, economy, convenience, aesthetics, and safety. However, a good place should be a combination of all what have been mentioned in this subparagraph.

1.3.2. Civic design and its relevance to security design principles

However, those above-mentioned design principles are more related to the work of planners rather than civilians itself. Nowadays, a trend of identifying space-users as a creator of environment, is quite actual. A lot of examples clarify the advantage of inhabitant's participation in planning

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processes. Due to the fact that, locals are the once who know the district and area better and they are the once who should use the space, they should know better what does that specific area requires. According to this, Civic design has much more power to create good public realm design and at the same time can be used as a strategy for humanizing anti-terrorism design principles. "Ideally, Civic design with Anti-terrorism design should not only protect people from upcoming attacks, but also engage them to understand a possible threat, design and encourage them to become a part of a citizenry in search of combat terror" (Rothrock, 2010).

A good explanation of Civic Design could be: "Civic Design is approaching how we use, plan, physically design and support our communities and the public realm in a way that benefits citizens, citizenship and the city" (Steiner, 2006).

Importance of Civic design has also been highlighted in second generation of crime prevention through environmental design. According to some scholars, the most important aspect of good and at the same time secured design, requires community mobilization as well as sense of neighborhood (Saville and Cleveland, 2003). Rothrock, in her research highlights five basic civic design principles:

- "Multi-lateral implementation;
- Accessibility;
- Safety;
- Stewardship;
- Education;" (Rothrock, 2010).

She strongly believes, that implementation of all this principle will create projects that "not only delight passerby's, but that engage with people in the public realm" (Rothrock, 2010).

Multi-lateral implementation (It comprises more than one group who are eager to implement their ideas in planning.) In the past, spaces have been created unilaterally, by a municipality or by a single person. However, it is believed that, civic design with a good result cannot be accomplished unless there are multiple organizations, or disciplines implemented in design processes.

Multi-lateral implementation is also defined as a concept of using messiness in planning cities "To think of cities as messy places will properly caution us against the use of exclusive, unidimensional, or egocentric actions. To respect the messiness of cities encourages the opportunity for pluralistic

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actions that not only will serve the very diverse interests of the city's people, but in the end, I maintain, will give greater delight and reward" (De Monchaux, 1989).

This strategy varies with the way most anti-terrorism design interventions are implemented. It is quite clear that responsibilities on anti-terrorism design has taken by a special governmental organization, security organization and designers. However, it is very important to make the planning process transparent for community as well.

Principle of accessibility in general has two major requirements. Firstly, anyone should be capable to find a place and should be allowed to go inside. It should not be a hidden place and should serves all potential users (old/young generations, disabled people etc.). Second, accessible place should be close to other major spots in a city.

Safety is an important measure of good civic design. It is an undeniable fact that if the place is not safe it will turn into not desirable, inaccessible space for civilians.

Stewardship is supervising and taking care of your community. According to the international dictionary 'civic minded' means "tending to do things that help your city or town and the people who live there" (Merriam-Webster, 2002). The main duty of civic design is to inspire people to take part in planning through maintaining the space or making it more interacted or even safer than before. A place that is being designed by people itself will automatically become important to people who live there and who contributed in creation of it.

Same principle can be implemented in anti-terrorism design. Police control is not enough for rising security. People themselves, should have a civic sense is important for planning secured spaces. This can be achieved by educating communities in a right direction.

Education It is a key to success. Educated community leads to a developed society, like so society becomes more than just the sum of people. In addition to that, a rise of public knowledge about the idea of their part in anti-terrorism design, will help citizens to be ready for any potential threats.

HYPOTHETICAL MODEL

Hypothetical model is based on literature, analysed in Chapter 1 of this thesis work. For building up a relevant literature based model for terrorism resilient cities, a physical as well as social aspects have been taken into account.

Looking through anti-terrorism design history and principles, vividly showing the importance of choosing and assessing right objects for implementing sophisticated security design strategies and reinforcing them against any possible terrorist attacks, while avoiding high number of causalities. Understanding terrorist motives and having ideas about their expectations after attacks can help designers and planners to diminish number of causalities (figure 10).
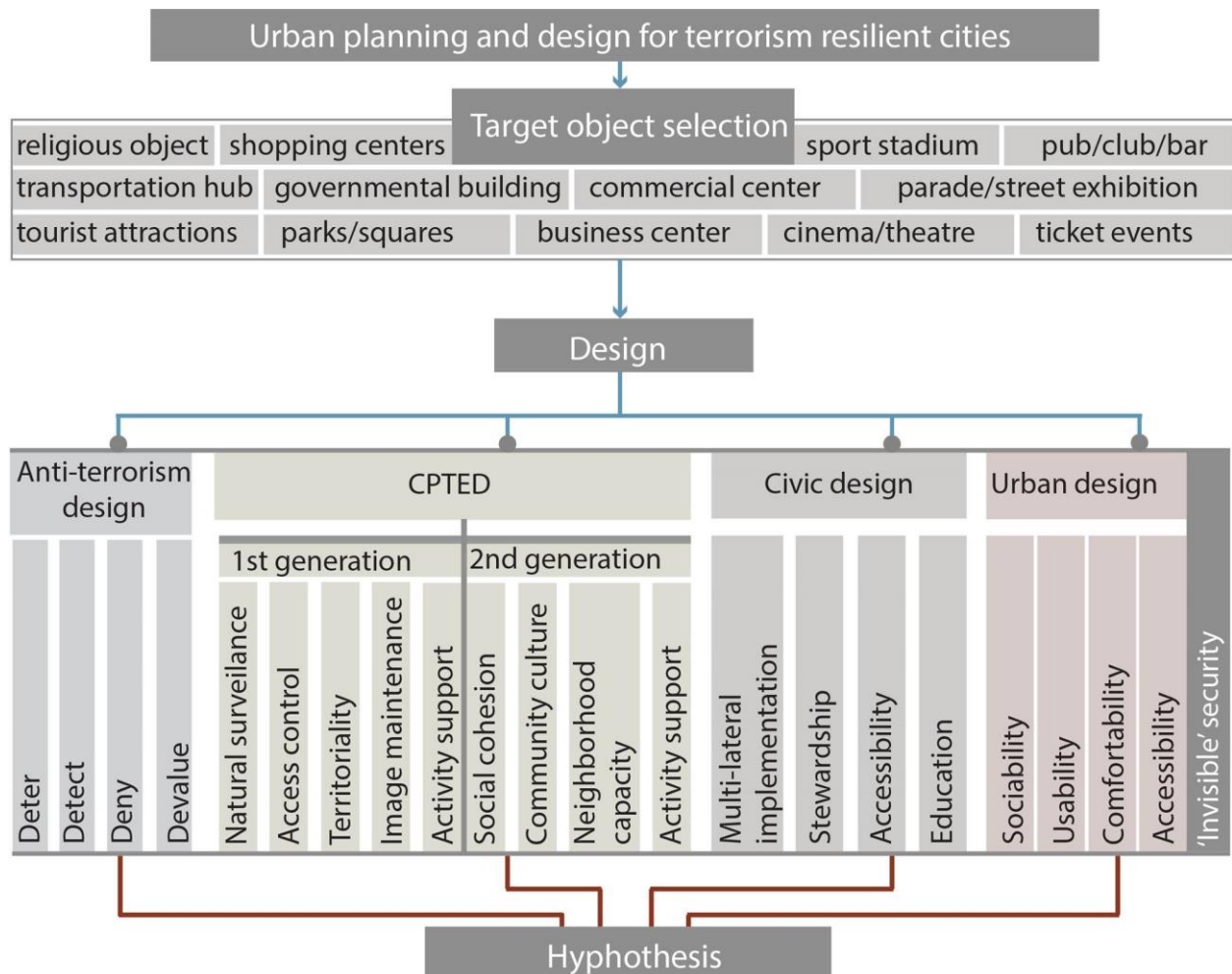

Figure 10 Hypothetical model for urban planning and design for terrorism resilient cities. Illustration prepared by author

- Hypothetical model starts with vulnerable target selection. For instance, sites with national as well as international importance (religious objects, objects with political values, and etc.), also crowded places, with high concentration of civilians (transportation hubs, sport stadiums, pubs/clubs/bars, shopping centers/shopping streets, tourist attraction spots, cinema, theatre, commercial centers, business centers, parks, squares, ticket event venues or open access events like parades or street exhibitions and etc.);

Hypothetical model considers anti-terrorism design main principles and its guidelines. For organizing main hypothesis, it uses 'four Ds' strategy: deter, detect, devalue, and deny (FEMA 426, 2003);

1. *Deter:*
- for decreasing site vulnerability, hypothetical model suggests various anti-terrorism design elements specially for preventing vehicles penetrate into vulnerable areas. physical barriers, bollards, special signs, lights, reinforced street furniture, plantings, monuments, planters, heavy objects and trees, water obstacles/mounds, jersey barriers, fences, NOGO barriers, tiger traps, and etc. it is important, that all anti-terrorism design elements are hidden from offender's sight.
- hypothetical model suggests to increase a standoff distance (second layer of defense). In case of a high density, it offers surrounding building reinforcement against blast explosion (evacuation and mandatory distances); In addition to that, it suggests building to be surrounded by specially designed plaza. In case of not existence a sufficient standoff zone, hypothetical model considers the idea of keeping vulnerable same functional objects closer to each other, in order to make potential vulnerable targets easier to protect.
- apart from this, it is important to minimalize vehicle access points to vulnerable buildings to elude potential attacks;
- as far as vehicles are potential threat for vulnerable site, hypothetical model organizes parking away from attractive target objects for terrorists. Moreover, it considers following principles: provide appropriate setback between parking and building, that needs protection; clearly marked location for parking lots and separated from pedestrian flows; provides appropriate setback between parking and building, that needs protection; suggests one-way circulation to facilitate to have an easy surveillance on vehicles;
2. *Detect:*

- suggests open space around site, as far as it makes it easier to monitor activities around the perimeter;
- suggests minimalizing hidden places to achieve detection on the perimeter;
- suggests natural surveillance, as far as it is crucially important that site is seen from every corner;
- suggests using CCTV cameras and police force presence on the site;
- suggests a tactic selection of planting, surrounding parking lots and other high-risk urban areas, so as not to disturb a natural surveillance.

3. *Deny:*
- in order to minimalize the chance of building collapse, hypothetical model suggests to reinforce building envelope as well as inner structures.

4. *Devalue:*
- well-used sites are an attractive target for terrorists. Consequently, hypothetical models suggest regulating activities on vulnerable sites.

From Crime Prevention Through Environmental Design principles, hypothetical model uses 1st generation as well as 2nd generation CPTED key strategies:

1. First generation of CPTED:
- *Natural surveillance* suggests to have open gathering spaces; all areas should be equipped with lighting; design should avoid hidden places; site users should have an opportunity to monitor activities from their windows; police forces need to control the perimeter.
- *Access control* suggests to create visible or invisible barriers for controlling perimeters; diminish number of escape routes; use landscape elements and signage to clearly guide visitors to and from the site;
- *Territoriality* suggests strong separation between private and public and semi-public activities defined by fences, walls, and planting barriers. Businesses should be identified by wall signs.
- *Image maintenance* suggests to restrict activities, that can damage neighborhood image and its functioning;
- *Activity support* encourages site to be loaded with various safe activities, as far as it makes it easier to detect potential criminals.

2. Second generation of CPTED:

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- *Social cohesion* suggests social partnerships for organizing events, strong relationship links with other neighborhoods.
- *Community culture* suggests organizing events for outlining neighborhood character.
- *Neighborhood capacity* suggests to support activities from neighborhood communities;
- *Connectivity* suggests to strengthen community by referring various activities to neighborhoods. For instance: common public transport, that therefore connects neighborhoods and etc.

In order to humanize security design features, hypothetical model will consider urban planning as well as civic design principles.

1. Urban planning:
- suggests key elements that creates desirable places: sociability, usability, comfortability, accessibility;

2. Civic design:
- *Multi-lateral implementation* suggests to allow more social groups to take part in planning process;
- *accessibility* suggests places to be accessible for everyone;
- *stewardship* suggests social participation in controlling and taking care of their own neighborhoods;
- *education* suggests developed community by educating neighborhood members.

In order to avoid presence of unaesthetic security elements on the site, that steal the city its soul and creating fear among civilians, hypothetical model will use 'invisible security' as an additional design strategy.

- hypothetical model suggests to hide security elements behind aesthetically expressive design features;
- suggests to encourage public realm on vulnerable sites, by allowing civilians to use and discover all facilities provided by sites without fear of possible attacks, created by immense walls, fences barricades, a lot of prohibition signs and etc.
- suggests to respect existing city layout, its historical and natural landscape;
- suggests to make changes on street network reorganization, by considering London 'ring of the steel' as a good reference by strongly defining entry and exit points to and from the city.

In addition to that, hypothetical model suggests to avoids streets with liner layout and prioritizing sinuous cul-de sac roads as well as avoid vulnerable buildings on major roads.

CONCLUSIONS

In final analysis, we can deduce that anti-terrorism design has a long history and practice in an urban environment. Although, it has always been more militaristic, than welcoming, only concentrated on particular problems, such are investigating potential threats and implementing security design strategies without considering existing urban character. Even though, there are number of publications that can be used as guidelines for creating protective places, there is not one size fit solution for each site.

- In the past, cities used to provide protection to its dwellers with help of immense walls and fortifications. However, life outside city gates, as well as commuting from one city to another had always been dangerous for civilians. Later on, a new necessity of organizing secured cities had highlighted. It is known as the principle of 'satellite towns', based on the concept of scattered infrastructural cores, in order to avoid high number of causalities, as well as city dysfunction problems that typically follows any kinds of attacks. As a good example of contemporizing past sophisticated ideas, in order to provide dwellers with high level of security inside the city, can be London 'ring of the steel'. This 'experimental traffic scheme' strategy uses modern devices, mobilized police, bollards, planters, CCTV cameras, various anti-terrorism design features, strongly defined entry and exit points to and from London downtown, instead of immense fortification walls. Those 'invisible' security design elements, are a modernized idea of 'fortifying' city. Though, in a more humanized way.

- Looking through terrorism cases and statistics on frequency of choosing a particular target object, while avoiding others, scholars have agreed that crowded places are more likely turning into targets for terror attacks. Most frequently, crowded places considered as a 'soft targets', rather than 'hard targets'. In the past, frequently targeted sites were major cities, with high concentration of civilians. Nowadays, all major places in the city that has a high number of users, are considered as potential venues for upcoming attacks. It is an undeniable fact that, knowing in advance what to protect, will diminish the chance of successful attack, with desirable results for terrorists.

- Turning into anti-terrorism design principles, it has been outlined that the main goal for counter-terrorism is to 'deter', 'detect', 'deny' and to 'devalue' vulnerable buildings. Those four anti-terrorism strategies can be accomplished by various scales of physical interventions. For instance: organizing standoff distances, equipping site with relevant environmental elements that can diminish a success rate of attacks. Considering civilians attitude towards environmental elements that has

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been erected for the reason of protection, the importance of 'invisible' security has been highlighted. Consequently, it has been proved that irrelevant designs for security, can have opposite effects, such are: fearfulness, suspicious, paranoia and etc. among civilians.

- According to what has been reviewed about Crime Prevention Through Environmental Design principles, we can deduce that CPTED, compared to anti-terrorism design is more concentrated on changes in social context and behavior, by means of improving community culture and understanding the necessity of safer environment for civilians. This concept is more vivid in contemporary CPTED (2nd generation of CPTED) that has turned into more community dominant design strategy. Social interaction is used as a design tool for security planning. As for 1st generation of CPTED, it suggests a humanized design solutions, that will not have a significant impact on already built environment.

- It has inclined to believe that understanding key principles of CPTED, that is suited to the public realm rather than contemporary anti-terrorism design strategies, will support the main idea of thesis, cooperation between crime prevention through environmental design and anti-terrorism principles will lead to more open strategies for society, with help of considering social interaction as a significant part of design processes.

- The vitality of considering both urban design and civic design principles has been highlighted in this chapter. It has inclined to believe that civic and urban design will lead to secured places with help of humanizing security design principles and without a dramatic impact on the 'image' of the city.

It has been outlined by chapter 1 that implementing all three strategies together, in search of creating 'invisible' security, can be successfully achieved in a scale of a site, rather than the scale of a single building. According to this, chapter 2 will describe a process of empirical research in order to highlight environmental features and spatial urban structures for safer environment.

CHAPTER 2

Empirical research for identifying environmental features and spatial urban structures for anti-terrorism design

2.1. Hypothesis and methodology for selected case studies:

2.1.1. Research hypotheses formed by anti-terrorism design and CPTED principles

As has been mentioned in introduction, research related to urban forms encloses two different parts and two different approaches to the issue. First part, a questionnair based survey, is aiming on identifying urban elements and forms, firmly connecting with terror attacks, while second part of a research is more related to road network reorganization strategies.

After analysing existing literature and recent researches about anti-terrorism design, CPTED strategies, urban and civic design principles, research hypothesis has been formed.

- Physical and natural barriers, preventing access to vulnerable targets, can elude potential threat;
- Increasing standoff distance by dispersing same functional buildings close to each other, will diminish a chance of terror attacks;
- Reduced number of vehicle access points to the building, as well as separation between vehicle and pedestrian flows, will evade a possible threat.
- Considering security design principles for parking lots, will elude potential danger from vehicles;
- Site that is constantly monitored, will less likely turn into a venue of terror attack;
- Site surrounding with open space can provide the area with natural surveillance and easy detection of potential offenders;
- Avoiding areas, where offender can hide without being detected by natural or continues surveillance, can decrease the chance of terror attacks;
- Well-used site, with diversity of activities and functional zones, will determine choice of places for terror attacks.
- Site with a strong separation between private and public properties, as well as activities, is less likely turning into a terrorist target object;
- Putting unsafe activities in vulnerable site, will turn it into attractive target for terrorists;

- High integrated roads, with a lot of connector roads, can determine choice of places for terror attacks.

- Site with direct access to the main street, as well as to the city center can be turned into the venue for terror attacks;

2.1.2. Empirical research methodology

Turning into the methods that have been used to carry out empirical field research. Main task of this chapter is to test hypotheses formed after reviewing anti-terrorism, CPTED, civic and urban design literature. Research comprises two different approaches to the issue: first part "identifies environmental design (CPTED) features that influence choice of places for terrorist attacks, as for second part it identifies factors of spatial urban structure that influence choice of places for terror attacks" (Matijosaitiene and Petriashvili, 2017). These two ways of investigation require implementation of various methodologies.

Research starts with collecting data for selected research objects: main target buildings, purpose of an attack, program on the site, organizing zoning plan, and etc.

For carrying out first part of a research, CPTED questionnaire has been developed based on the site assessment checklist (CPTED) and FEMA guidelines. Questionnairer has 39 'Yes'/'No' type questions, organized according to CPTED key strategies (elements of surveillance, elements of access control and target hardening, elements of territoriality, elements of activity support, elements of site management and maintenance). For assessing selected sites and getting precise results, field research has taken following steps:

- gathering aerial pictures of selected sites, street views and information about attacks provided by various articles;
- observing site for no less than 10 minutes and assessing all environmental features from the questioner by giving "Yes" or "No" answers. "Yes" when element meets security design principles and "No" when they do not.
- using correlation analysis in search of identifying CPTED elements related to terror attach;
- using automatic regression to build a prediction model for terror attacks.
- applying descriptive statistics to outline weakest design areas of analysed objects, that has been affected by terror attacks.

Tools that has been used for carrying out first part of a research are the following: articles/publications; Google Earth Pro; IBM SPSS statistics software.

The main aim of the second part of this research is to identify factors of spatial urban structure, influencing choice of places by terrorists, has been carried out with help of Space Syntax (SS) visual

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analysis. In search of discovering urban features that can be a cause of choosing particular sites for terror attacks while avoiding others, all major space organizing attributes have taken into account: connectivity, choice, mean depth and integration. (*connectivity* measures how many roads are connected to particular road segment; *choice* measures how likely a street segment is passed through all shortest routes from all spaces to each segment; *mean depth* is a distance form each road segment center point until other streets segment center points; *integration* measures number of turns that is required to get from one street segment to other street segments.)

The process of space analysis comprises following steps:

- deciding on 8-meter radius spaces for analysis around terror attack venues;
- creating relevant working maps (maps with single lines instead of polylines) of a selected city with marked attack points;
- using a Depth Map software for investigating attributes: connectivity, integration, choice, and mean depth
- using axial map analysis (*axial map* analysis is implemented on an accurate map. It draws intersected lines on urban grid in order to cover all grids and indicates rings of circulation).

Tools that have been used for carrying out second part of a research are the following: DepthMap software and AutoCad for creating accurate maps.

After acquiring relevant results from both parts of a research, thesis will form appropriate conclusions and build up a conceptual model for terrorism resilient urban patterns.

2.1.3. Case studies and research objects

According to the recent terrorist cases, decision was made on choosing and analyzing sites are located in Europe: Brussel, Liege, Oslo, Paris, Volgograd, Diyarbakir, and Stockholm as well as some sites in Asia (mostly cities that have European city planning principles) Such as**:** Ankara, Istanbul and Tel-Aviv. All of these above-mentioned cities were used for first part of the research as for second part decision was made on Brussel, Ankara, Istanbul and Tel-Aviv. Difference in number of analysed cities has been caused by different requirements for researches. Questionnaire based survey required analysing more sites for more accurate and truthful results, while Space syntax analysis could have been done for a few number of sites. Following terror attack cases have been evaluated by means of site function, purpose of attack and target objects.

It is important to be mentioned that all chosen cases are either suicide bombings, mass shooting, car bombing or all together. (Table 2_1; 2_2; 2_3; 2_4; 2_5; 2_6; 2_7; 2_8; 2_9; 2_{10}; 2_{11}; 2_{12}; 2_{13}; 2_{14})

Table 2_1 Case study: Ankara, central railway station. Illustration prepared by author

Location	Turkey, Ankara
Target object	Ankara central railway station
Year of an attack	2015, October 10th
Methods of an attack	Suicide Bombing
Purpose of an attack	Political (Targeted Protestants)
Loss	109 dead and 400+ injured
Buildings primary purposes	Public buildings: railway station, stadiums/sport hall, governmental office, parks
Critical activities take place at the buildings	In that particular situation, it was the venue of a strike
Site's occupants and visitors	Civilians using site for public purposes, Students and politicians
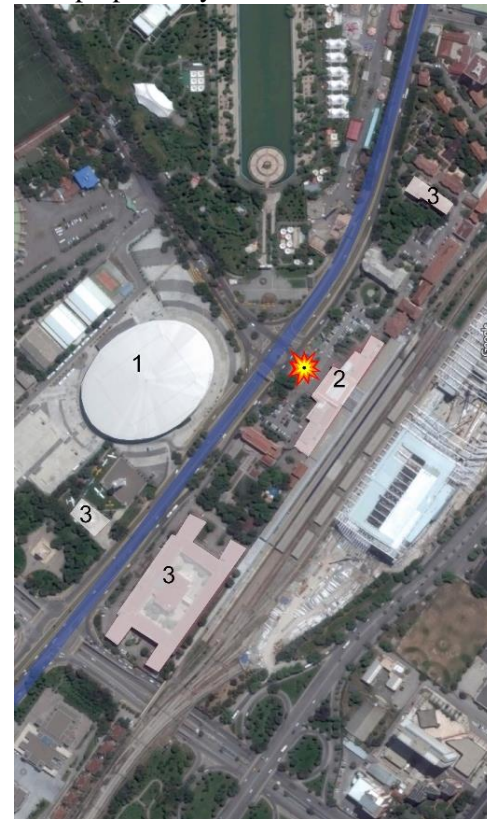
1. Ankara Stadium;
2. Railway station;
3. Governmental offices;

Table 2₂ Case study: Ankara, bus stop. Illustration prepared by author

Location	Turkey, Ankara
Target object	Bus stop
Year of an attack	2016, March 13th
Methods of an attack	Car bombing, Suicide bombing
Purpose of an attack	Political (main target: security forces)
Loss	37 dead and 127 injured
Buildings primary purposes	Governmental offices, Public work department, Shopping malls, banks and financial offices, (nearby: Ankara station, metro station, parks)
Critical activities take place at the buildings	Area is a major transportation hub of the city, presented with number of bus stops. In addition to this it is a crossroad of major bus lines
Site's occupants and visitors	Civilians and politicians

1. Governmental offices
2. Public work departments;
3. Sgopping center
4. Financial offices;

Table 2₃ Case study: Ankara, military headquarter. Illustration prepared by author

Location	Turkey, Ankara
Target object	Military headquarter
Year of an attack	2016, February 17th
Methods of an attack	Suicide Bombing, car bombing
Purpose of an attack	Political (Target Military personnel)
Loss	28 dead and 60 injured
Buildings primary purposes	Headquarter of the army and Turkish parliament, Residential district with headquarter of high ranking military personnel, (nearby: stadium)
Critical activities take place at the buildings	Site is mainly used for military purposes
Site's occupants and visitors	Military personnel, politicians, civilians

1. The armed force school Headquarter of the army
2. Governmental buildings

Table 2₄ Case study: Brussels, Maalbeek station. Illustration prepared by author

Location	Belgium, Brussels
Target object	Transport Hub, Maalbeek station
Year of an attack	2016 March 22ⁿᵈ
Methods of an attack	Suicide bombing, mass shooting
Purpose of an attack	Political
Loss	35 dead and 340 injured
Buildings primary purposes	Station, close to number of EU institutions, Governmental buildings
Critical activities take place at the buildings	Site is mainly used for business and political purposes
Site's occupants and visitors	EU commission members, civilians, politicians

Table 2₅ Case study: Liege, St. Lamberts square. Illustration prepared by author

Location	Belgium, Liege
Target object	Saint Lambert Square
Year of an attack	2011 December 13ᵗʰ
Methods of an attack	Suicide bombing, mass shooting
Purpose of an attack	Unknown
Loss	7 dead and 125 injured
Buildings primary purposes	Town's court building, Museum, Saint lamberts castle, bank offices
Critical activities take place at the buildings	Site has tourist attraction spots _tourism
Site's occupants and visitors	Civilians, tourists

1. EU commision building
2. Bussiness center
3. Governmental building

1. Castle
2. Cathedral
3. Museum

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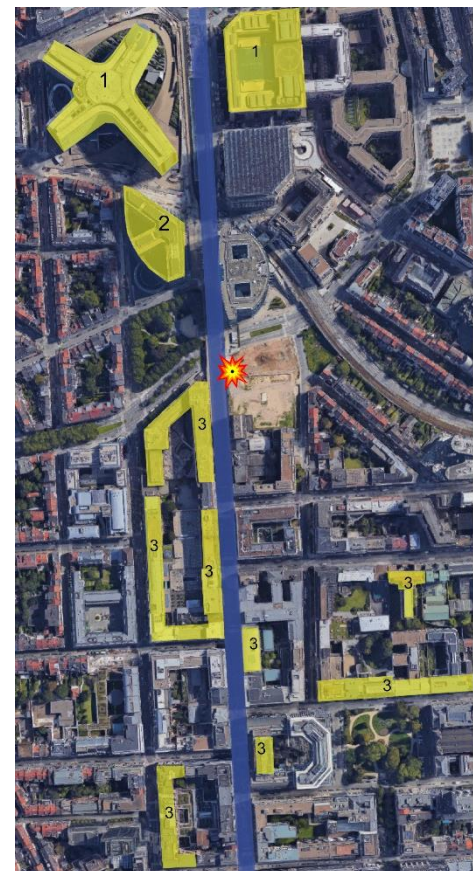
Table 2₆ Case study: Istanbul, Istaklal avenue. Illustration prepared by author

Location	Turkey, Istanbul
Target object	Shopping area, Istiklal Ave.
Year of an attack	2016 March 19th
Methods of an attack	Suicide bombing
Purpose of an attack	Unknown
Loss	4 dead and 36 injured
Buildings primary purposes	Shopping malls, various entertainment venues, restaurants, governmental buildings, mosque
Critical activities take place at the buildings	Shopping, leisure activities
Site's occupants and visitors	Civilians, mostly foreign tourists

1. Mixed use Food objects
2. Mixed use Shopping
3. Leasure Centers
4. Governmental Building
5. Mosque

Table 2₇ Case study: Tel-Av-Iv. Illustration prepared by author

Location	Turkey, Tel-Av-Iv
Target object	Small businesses
Year of an attack	2016 (January 1st)
Methods of an attack	Mass shooting
Purpose of an attack	Unknown
Loss	3 dead and 7 injured
Buildings primary purposes	Various public buildings_ restaurants, cafes, small businesses. Mostly entertainment spots.
Critical activities take place at the buildings	Leisure activities
Site's occupants and visitors	Civilians, tourists

1. Residental buildings
2. Private comemrcial buildings

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Table 2₈ Case study: Ankara military headquarter.

Illustration prepared by author

Location	Russia, Volgograd
Target object	Trolleybus
Year of an attack	2013 December 30th
Methods of an attack	Suicide bombing
Purpose of an attack	Unknown
Loss	16 dead and 85 injured
Buildings primary purposes	Residential district small private businesses
Critical activities take place at the buildings	Daily activities, living areas
Site's occupants and visitors	Residents, civilians

Table 2₉ Case study: Istanbul, Sultan Ahmet dist.

Illustration prepared by author

Location	Turkey, Istanbul
Target object	Istanbul historic Sultan Ahmet dist.
Year of an attack	2016 January 12th
Methods of an attack	Suicide bombing
Purpose of an attack	Both political and religious
Loss	13 dead and 14 injured
Buildings primary purposes	Museums, Governmental offices, Obelisk of Theodosius, Mosque
Critical activities take place at the buildings	Tourist attraction site
Site's occupants and visitors	Mostly tourists

1. Governmental Building
2. Mosque
3. Muesum

Table 2₁₀ Case study: Diyarbakir, governmental offices.

Illustration prepared by author

Location	Turkey, Diyarbakir
Target object	Governmental offices
Year of an attack	2015 June 5th
Methods of an attack	Bombing
Purpose of an attack	Political, target group: People's democratic party supporters
Loss	4 dead and 100+ injured
Buildings primary purposes	Mosque, Commercial buildings, University, governmental offices,
Critical activities take place at the buildings	In that particular situation, there was an electoral rally of the people's democratic party.
Site's occupants and visitors	Civilians

1. Station
2. Mosque
3. Residential buildings
4. Adana and Mersin branch offices

Table 2₁₁ Case study: Paris, 'Stade de France'. Illustration prepared by author

Location	France, Paris
Target object	Stadium of France "Stade de France"
Year of an attack	2015 November 13th
Methods of an attack	Suicide bombing
Purpose of an attack	Political
Loss	137 dead and 368 injured
Buildings primary purposes	Stadiums, leisure center, hotels
Critical activities take place at the buildings	Public building, venue of gathering
Site's occupants and visitors	Tourists, civilians

1. Stadium
2. Leisure center
3. Hotel

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Table 2₁₂ Case study: Paris, boulevard Voltaire. Illustration prepared by author

Location	France, Paris
Target object	Boulevard Voltaire
Year of an attack	2015 November 13th
Methods of an attack	Suicide bombing
Purpose of an attack	Political
Loss	137 dead and 368 injured
Buildings primary purposes	Mixed use shopping and entertainment places
Critical activities take place at the buildings	Shopping, tourist attraction spots
Site's occupants and visitors	Civilians, tourists

1. Mixed use Shopping

Table 2₁₃ Case study: Oslo, governmental headquarter. Illustration prepared by author

Location	Norway, Oslo
Target object	Governmental headquarter
Year of an attack	2011 July 22nd
Methods of an attack	Car bombing, mass shooting
Purpose of an attack	Political
Loss	77 dead, 319 injured
Buildings primary purposes	Governmental, residential
Critical activities take place at the buildings	Political
Site's occupants and visitors	Politicians
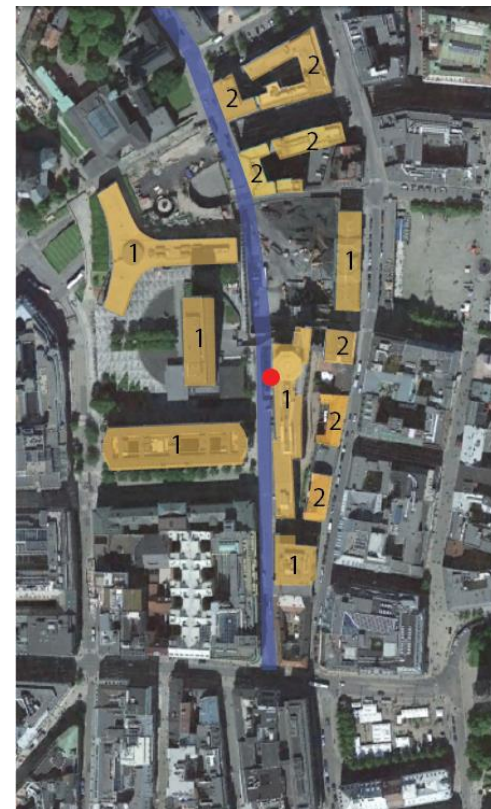
1. Governmental buildings;
2. Residential buildings;

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Table 2₁₄ Case study: Sweden, boulevard Voltaire. Illustration prepared by author

Location	Sweden, Stockholm
Target object	Drottninggatan, shopping street
Year of an attack	2010 December 11th
Methods of an attack	Suicide bombing
Purpose of an attack	Unknown
Loss	2 dead
Buildings primary purposes	Shopping centers
Critical activities take place at the buildings	Shopping
Site's occupants and visitors	Civilians

1. Shopping centers
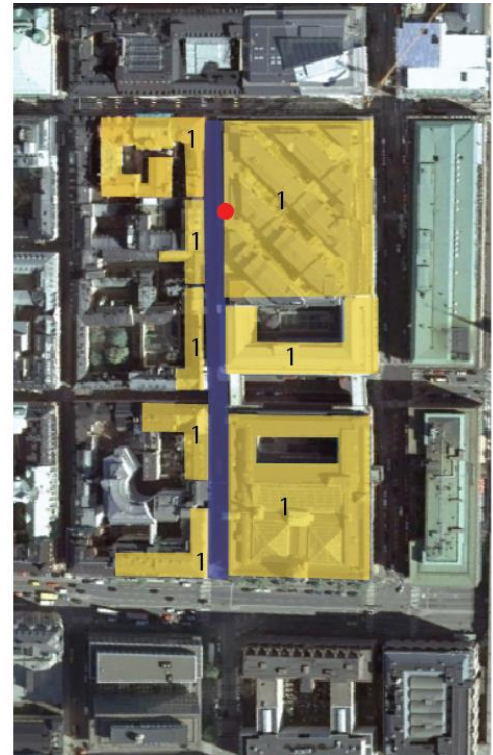
In conclusions, research can point out main aspects of recent terrorist attacks. It is a vivid fact, that analysed attack cases are mainly performed by politically motivated aggressors. Consequently, target objects are mostly governmental headquarters. Although, number of cases happened in cultural districts or touristic areas as well as in transportation hubs.

2.2. Research on environmental design (CPTED) features influencing choice of places for terror attacks:

2.2.1. Questionnaire based research process

In all above-mentioned cities, a terror attack venues have evaluated by 'Yes/No' questionnaire. The questionnaire designed based on analysed literature as well as CPTED site assessment checklists and FEMA Guidelines for counterterrorism principles. 38 questions are organized in 5 different blocks, according to 5 key CPTED strategies:

1) Elements of surveillance:

Variable 1. Does site or object surrounded by an open space?

Variable 2. Does site or object can be seen from every corner?

Variable 3. Are there any blind spots or hidden areas?

Variable 4. Does landscape create blind or hidden spots?

Variable 5. Are there any blind walls?

Variable 6. Are there any place where offenders could easily hide and conceal themselves?

2) Elements of access control and target hardening:

Variable 7. Does site have a direct access to the main street?

Variable 8. Are there multiple entrances and exits to and from the site?

Variable 9. Does most of major building in the site has separated entrances for vehicles and for people respectively?

Variable 10. Is there vehicle and pedestrian access control elements at the perimeter of the site?

Variable 11. Are there enough and appropriate perimeter barriers capable of stopping vehicles?

Variable 12. Can high speed vehicle directly penetrate to major buildings situated on the site?

Variable 13. Does the site's road system prevent high-speed approaches by vehicles?

Variable 14. Does the site landscaping and street furniture provide hidden places?

Variable 15. Are hardening elements hidden from potential offender sight?

Variable 16. Are bollards and street furniture creating a hidden layer of defense?

Variable 17. Are there any signs controlling vehicle and pedestrian flow?

Variable 18. Is there security/police presence on the site?

Variable 19. Are vehicle access points to the building minimalized?

3) Elements of territoriality:

Variable 20. Does the design provide a continuous line of defense around the site as far from the building as possible?

Variable 21. Is distance from the building and site boundaries maximized?

Variable 22. Do businesses and buildings identified by wall signs?

Variable 23. Are property lines and private areas defined with plantings, pavement treatments, short walls, fences as well as bollard system?

Variable 24. Are trees and plants creating second layer of site defense?

Variable 25. Are parking areas clearly marked and separated from pedestrian walkways?

4) Elements of site management:

Variable 26. Are public toilets, service spaces or access to stairs, elevators located in any non-secure areas?

Variable 27. Is access to private and public space clearly defined?

Variable 28. Are there any governmental, military or recreational facilities that impact transportation?

Variable 29. Is there any medical institution nearby the site?

Variable 30. Is there a minimum setback distance between the building and parked vehicle?

Variable 31. Does site have a direct access to the city center?

5) Elements of activity support:

Variable 32. Are public and private activities separated?

Variable 33. Is the site well-used?

Variable 34. Is there a diverse range of land-uses on the site?

Variable 35. Are there many same functional buildings redistributed in the surrounding area?

Variable 36. Does the site has political or religious values or both together?

Variable 37. Are there restaurants/cafes/cinemas/play areas to attract people?

Variable 38. Is the site frequently a venue of public activities?

After the questions were filled, 'Yes' and 'No' answers were given numeric values. 'Yes'-1, when site meets security design standards; 'No'-0, when site do not meet security design standards. Although, structure of some questions (when answer 'Yes' on the question is negative and 'No' positive) requires opposite values. (Yes-0; No-1)

Results from questioner later analysed with:

- data comparison diagrams (assessed only those sites, affected by terror attacks);
- data correlation analyses.

In total 14 sites with terror attack and 21 sites without terror attack cases have been assessed with CPTED questionnaire. It is important to compare urban elements in areas that has been affected by terror attacks to the areas that has not affected by attacks to define degree of association with nominal variable to the number of terror attacks.

Owing to the fact that data provided by questioner (Yes/No questions) is nominal, Eta-square and Chi-square analyses were being carried out. In another word "for the identification of relations between nominal variables (elements of urban environment from the questionnaire that can be answered 'Yes' or 'No') and scale variables (number of terror attacks) Eta-squared correlation analysis and Chi-squared test are applied" (Matijosaitiene and Petriashvili, 2017).

A measure of association Eta-squared "correlation value 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 between the variables" (IBM Knowledge Center). Eta-square correlation analysis has chosen, because one variable in this case environmental design features are from categorical group while number of terrorism cases are from quantitative group. "Eta 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" (IBM Knowledge Center). Small correlation is being observed at η^2=0.02, medium correlation is when η^2=0.13, large correlation is when η^2=0.26. As for Chi-squared test (with another name 'Pearson's chi-square test' or 'chi-square test of association) is relevant to use in cases, when it is required to identify if there is a significant relation between two or more categorical variables (represented by 2X2 table), in this case between urban elements. After correlation analysis, a liner regression analysis has been implemented in order to predict the value of one variable (Environmental element), that based on the value of another variable (number of terror attacks). Results from liner regression analysis will be discussed later in the text. Statistical Package for the Social Sciences (SPSS) was used for carrying out this research.

2.2.2. Results from data correlation analysis

To outline main environmental design features (assessed by CPTED questioner) that can be determinant factors for choosing a specific area for terror attacks, quantitative results from 'Yes/No' questioner have been examined with Eta-squared correlation analysis (η^2). In addition to this Chi-square tests are applied (χ^2). According to results from correlation analysis, there is a relation between terror attacks and following environmental design factors (Table 1) (η^2 Eta-square; χ^2 Chi-square; $p_{(1)}$ 2-sided significance ; $p_{(2)}$ significance)(table 3):

- *A strong separation of private and public activities* is connected to terror attacks (χ^2=14.583, p=0.00<0.05 and η^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 that on itself controlled independently can be understood as one of counterterrorism as well as CPTED principles. Private areas should be defined by small fences and site boundaries. A strong separation between private and public areas will reduce crime rate and terrorist activities respectively.

- *A site that has a direct access to the main street* is connected to terror attacks (χ^2=4.762, p=0.029<0.05, η^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 on it is quite significant. Consequently, in most cases this feature can be associated with terror attack.

- *A site that has a multiple entrances and exits are more likely to turn into the target of terror attacks* (χ^2=5.250, p=0.022<0.05, η^2=0.188, p=0.021<0.05). Multiple number of entrances and exits to and from the site is associated with vulnerable and not terrorism resistant areas. According to FEMA guidelines a site should have two entrances and exits (one of them for emergency purposes) (FEMA 430, 2007).

- *Minimization of vehicle access points to the building* is connected to terror attacks (χ^2=5.000, p=0.025<0.05 and η^2=0.333, p=0.024<0.05). Controlling all existing vehicle access points is necessary for anti-terrorism design. Although, minimalizing number of accesses to the object can diminish chances of an attack and therefore, will give us a possibility to make a minimum standoff distance.

- *Access to private and public space is clearly defined* (χ^2=6.087, p=0.014<0.05, η^2=0.217, p=0.012<0.05). Finishes and signage should be designed for visual simplicity in order to define private, semi-public and public spaces.

- *When a site has a direct access to the city center it more likely turns into a target of terror attacks* (χ^2=6.300, p=0.012<0.05, η^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 'soft' targets and achieve huge number of causalities, city centers and major roads mostly turning into venues of terror attacks.

- *Site is well used* (χ^2=6.087, p=0.014<0.05 and η^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 circumstance can turn it into an unsafe place and attractive target for terrorists.

- *Redistribution of same functional buildings on the site* can turn the area into the venue of terror attack (χ^2=7.337, p=0.014<0.05 and η^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* (χ^2=7.350, p=0.007<0.05 and η^2=0.490, p=0.004<0.05) (Matijosaitiene and Petriashvili, 2017)

	Urban Environment factors	Terrorism
Elements of access control and target	Site has a direct access to the main street	χ^2=4.762, p=0.029<0.05, η^2=0.170, p=0.029<5
	There are multiple entrances and exits to and from the site	χ^2=5.250, p=0.022<0.05, η^2=0.188, p=0.021<5
	Vehicle access points to the building is minimalized	χ^2=5.000 p=0.025<0.05 η^2=0.333 p=0.024<0.05
Elements of activity support	A medical institution is presented nearby the site	χ^2=7.350 p=0.007<0.05 η^2=0.490 p=0.004<0.05
	Public and private activities are separated	χ^2=14.583, p=0.00<0.05 and η^2=0.521, p=0.00<0.05
	Site is well used	χ^2=6.087, p=0.014<0.05 η^2=0.217, p=0.012<0.05
	Many same functional buildings redistributed in the surrounding area	χ^2=7.337, p=0.014<0.05 η^2=0.217, p=0.012<0.05
Elements of site management	Access to private and public space is clearly defined	χ^2=6.087, p=0.014<0.05, η^2=0.217, p=0.012<5
	Site has a direct access to the city center	χ^2=6.300, p=0.012<0.05, η^2=0.225, p=0.011<5

Table 3 Highlighted urban features and their correlation with terror attack cases. (Table prepared by the author).

The following graphic demonstrate how important variable 8, 20, 28, 30, 32, 33, 34 and variable 36 are for the whole model of predictions of terror attacks (figure 11). (Variable 8, question 2.2. *Are there multiple entrances and exits to and from the site*; variable 20, question 2.14. *Vehicle access points to the buildings are minimized*; Variable 30, question *Is there any medical institution nearby the site?*; Variable 33, question *Are public and private acivities separated?*; Variable 36, question *Are there many same functional buildings redistributed in the surrounding area?*)

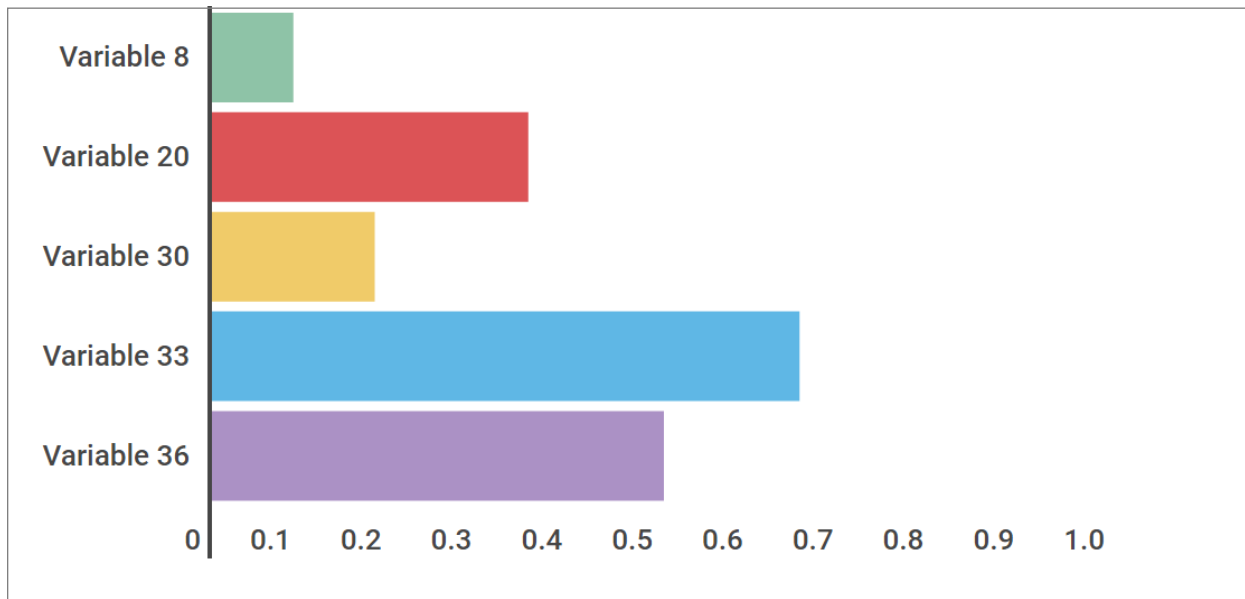**Figure 11** Importance of variables for the choice of places for terror attacks (Illustration prepared by author)

According to the graph variables 33 and 36 have shown a strong correlation with terror attacks, that means elements of activity supports and site functioning are a determinant factor related to the choice of terror attacks. Both features can be successfully implemented in counterterrorism deign strategies.

2.2.3. Results from comparative analysis and descriptive statistics

Later, results from obtained data ('Yes/No' CPTED questioner) has been evaluated with comparative analysis. Process of analysing data with descriptive statistics, highlighted some environmental features that has or has not a significance connection with the terror attack. In order to get more precise results, questions that has vivid disproportional answers have been selected (When negative answer>Positive answer). Those questions are following:

Negative responses from sites with terror attack cases:

Does the site or object surrounded by an open space? (Var.1) (4 positive/10 negative);

Site has a direct access to the main street. (Var.7) (1 positive/13 negative);

Are there multiple entrances and exits to and from the site? (Var.8) (4 positive/10 Negative);

Is there security police presence at the site? (Var.19) (4 positive/10 negative);

Vehicle access points to the building are minimalized; (Var.20) (3 positive/ 11 negative);

Is there a minimum setback distance between the building and site boundaries? (Var. 31) (4 positive/10 negative);

The site has a direct access to the city center. (Var. 32) (1 positive/ 13 negative);

Are public and private activities separated? (Var. 33) (1 positive/13 negative);

Is the site well-used? (Var. 34) (0 positive/ 14 negative);

Are there many same functional buildings redistributed in the surrounding area? (Var. 36) (2 positive/12 negative);

Are there restaurants, cafes, cinemas, play areas to attract people? (Var. 38) (3 positive /11 negative);

Is the site frequently a venue of public activities? (Var. 39) (4 positive /10 negative).

Descriptive statistics has shown that most of the site with terror attacks were surrounded by open space. We can deduce that even though open space can be beneficial for architectural point of view

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(for maximizing standoff distance, or easily redistributing blast loads) this particular feature can determine terrorist attacks and the choice of a particular area.

A similar explanation can be made for a Variable 2; when the site is located on the major road, its importance is higher, so as its asset value.

As it has been stated by counterterrorism principles site should have no more than two controlled accesses points. Descriptive statistics have shown that 10 sites out of 14 has multiple entrances to and from the site. Consequently, this circumstance can be considered as a determinant factor of an attack.

Almost none of examined places had any nearby police stations.

Variable 20 showed that most cases had easy vehicular access points that therefore rises vulnerability rate of a building.

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 terrorists. It turned out that just 4 sites out of 10 have sufficient standoff distances (variable 31).

The choice of venues of an attack could also be determined by their easy access to the city center. 13 sites out of 14 have a direct access to the center (variable 32). Data analysis has shown that separated public and private activities can be a reason for terror attacks (variable 33).

11 terror attack cases out of 14 have occurred in areas with clear zoning plan (variable 36);

According to the responses a high percentage of sites with terror attack cases are important among civilians by their functions (Public entertainment venues: restaurants, cinemas, theaters etc.) (var. 38, var. 39 and 34).

Comparative data analysis and descriptive statistics has also carried out for places with no terror attacks. However, in this case, selection was made on design and urban elements that has more positive responses than negative (Positive answers>Negative answers).

Positive responses from sites without terror attack cases:

 Are public and private activities separated? (Var. 33) (16 positive/ 5 negative);

 Are there many same functional buildings redistributed in the surrounding area? (Var. 36) (16 positive/ 5 negative);

Analysis on sites with appropriate design elements for meeting counterterrorism principles, has highlighted 2 variables that are more common for defendable places. In details, 16 out of 10 places had no significant separation of private and public activities. In addition to that most sites had a diversity of functions.

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 analysis of a questionnaire to correlation analysis results. This data will therefore highlight most important elements that should be implemented into design, such are: 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.

2.3. Research on spatial urban structure factors that influence choice of places for terror attacks:

2.3.1. Process of syntactical analysis

Second part of a research, starts with making maps (defining 8 km radius from attack points) for the following cities and its sites: Ankara (G. Mustafa Kemal Blvd.); Ankara 2016 February (Military headquarter); Ankara 2016 March (Ataturk Blvd.); Brussel 2016 (Maelbeek Metro Station); Istanbul 2016 (Istiklal avenue); Tel-Aviv 2016 (Dizengoff street);

Owing to the fact that a lot of cities after terror attacks have risen security levels by implementing counterterrorism design strategies in their vulnerable sites, making precise maps for syntactical analysis become a difficult task for a research. Consequently, decision was made on few sites, that has recently been affected by terror attacks.

Initially thesis will define general ideas of space syntax (SS), and the decision of choosing syntactic analysis for identifying specific urban structure factors. SS, main aim is to establish a relation between a spatial structure of cities and buildings with its user's behavior and their movement in a space. It seeks to reveal both the logic of architectural space at any scale and the spatial logic of spaces.

Studies on site maps for SS analysis, was performed by Depth Map software. For an urban scale, it is relevant to use axial map analysis, that is inclined to believe one of a key tool of SS. Initially, prepared maps are transformed into axial maps. Axial map allows researchers to create consistent maps with a concise description of a space. Axial maps are beneficial for the analysis of pedestrian movement patterns and various activities, that are related to this movements. (Hillier, 2004).

It is relevant to investigate SS key attributes in a different scale (in this case, local and global scales). "The scale is recorded in terms of a radius, centered on the segment in question, measured in metric distance" (Emo 2012). Graph analysis was being applied by global and local measures for site evaluation. Global radius N, that is largest possible radius and local radiuses has been selected: n, n2, n3 and n5. Those radiuses related to different scales of movement starting from most local ending with most global. In addition to that, it uses three different ideas of movement: "shortest path distance, fewest turns distance and least angle change distance" (Hillier and Stonor, 2010). For instance, global integration with radius n, shows how in a city each street is connected to all other streets in terms of the maximum possible direction changes. Integration with radius 2, shows how a

particular street is connected to other neighborhood streets in terms of 2 times direction change, in case of radius 3 and 5, 3 times direction change or 5 times direction change.

The most significant attributes for syntactical analysis has defined in advance, those are following:

- *Choice* (is calculated by mathematical 'betweenness) discovers, how likely is a particular street chosen to get to other segments in a space. Measuring choice value for the street, where terror attack occurred, will give us an idea of relationship between a value of choice and terror attack causalities;
- *Connectivity*, discovers street values by means of its connector roads. Measuring connectivity attribute for the street, where the terror attack occurred, will give us an idea weather roads with significant number of connectors are turning into a terrorist target or not;
- *integration*, (calculated by mathematical 'closeness') discovers how easy is it to get to a street segment from other street segments. Measuring integration value in the area of terror attack will give us an idea of relationship between highly integrated streets and terror attack causalities;
- *Mean depth and Total Depth*, "is calculated by assigning a depth value to each space according to how many spaces it is away from the original space" (Hillier and Hanson, 1984). Those attributes on itself will identify how deep are street segments in relation with terror attack venues. (Hillier and Stonor, 2010; Hillier and Hanson, 1984).

In search of carrying out a research, for identifying terrorist movements and their choices of particular places, axial map analysis have been carried out. Analysis considered a 2D layout model. Comparison of different SS attributes, by means of different cities, highlighted spatial urban structure factors that can have a significant relation with choosing a specific area for terror attacks.

2.3.2. Results from space syntax analysis

SS visual analysis of cities with recent terror attacks has pointed out some elements and urban features that might be the factor affecting the choice of specific area for terror attacks while avoiding others. Redistribution of a street network has come out a key factor while planning resilient cities.

A trustworthy result is determined by getting almost same illustrations of research sites axial analysis. However, Tel-Aviv was the only city where terrorist attack site was not located on the most integrated street, though it had quite high choice as well as local integration value. For better illustration table of important attribute for different areas has prepared (Table 4)

SS attributes/Cities	Ankara 2015	Ankara 2016, Feb.	Ankara 2016	Brussel	Tel Aviv	Istanbul
Choice [HH]	166096	257256	214618	785283	90731	375728
Choice [HH]R2	65	905	187	1329	211	413
Choice [HH]R3	786	5432	1374	9895	1790	1811
Choice [HH]R5	17491	45671	14409	125560	15683	11124
Connectivity	16	31	15	38	16	21
Integration[HH]	1.05396	1.10706	0.941496	1.68477	1.4472	0.636022
Integration[HH]R2	4.06308	5.96341	4.67173	6.2915	1.84996	5.36218
Integration[HH]R3	3.07462	3.79913	3.24801	4.04356	3.40704	3.26735
Integration[HH]R5	2.27004	2.22211	2.26146	2.67907	2.39621	2.18475
Mean Depth[HH]	9.74148	9.1423	10.9325	6.7091	6.11157	15.7976
Mean Depth[HH]R2	1.84746	1.71818	1.78571	1.7697	1.8139	1.63793
Mean Depth[HH]R3	2.65306	2.4125	2.53297	2.53968	2.57676	2.35772
Mean Depth[HH]R5	4.03688	3.73059	3.93929	4.0537	3.92095	3.57143

Table 4 SS important attributes numeric values for streets, affected by a recent terror attacks.

Axial map visual comparison by means of choice, connectivity, integration, and mean depth attributes, have pointed out that almost all examined terror attack sites are situated on a globally integrated road, with the radius N. (Figure 12,13)

Ankara, October 2016

Brussels, 2016

Ankara, February 2016

Ankara, March 2016

Figure 12 Illustration of global integration maps for research object sites. A terror attack venues are marked as a red dot. Warm color (Red, orange, yellow) lines mean the highest values of integration, and cold color (blue, green) lines mean the lowest values of integration.

Istanbul, 2016   Tel Aviv, 2016

Figure 13 Illustration of global integration maps for research object sites. A terror attack venues are marked as a red dot. Warm color (Red, orange, yellow) lines mean the highest values of integration, and cold color (blue, green) lines mean the lowest values of integration.
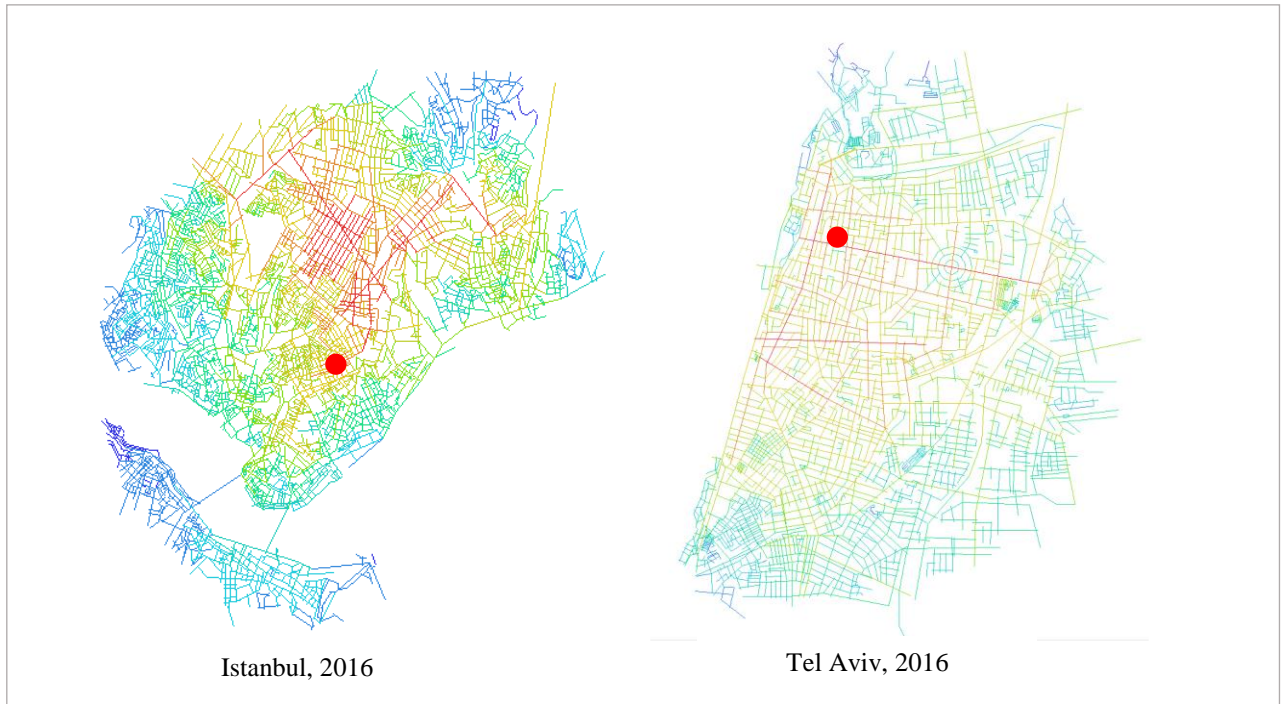
2.4. Prognosis, main findings, and recommendations:

2.4.1. Prognosis model of the place choice for terror attacks, based on logistic regression analysis

Using the logistic regression to the survey data (Yes/No answers, some prognosis models for particular variables (dependent variables) have been built. Urban features that we want to predict are dependent variables, as for number of terror attacks are values with the name independent variables. Independent variable is a predictor variable. This liner graphs can give us predictions on terror attacks in case of existence or not existence of particular variables. In addition to that it evaluates possibility of attacks from 0 to 1 scale that gives idea of its value (if prognoses number is closer to 1 there is less chance of terror attacks, if it is close to 0 than there is a higher chance).

Following graphs (Figure 14) are demonstrating the relation between Variables 40 -20 and variables 40-33: negative relation between Variable 40 and Variable 33 (when public and private activities separated (answer yes=1) the estimated mean value of terror attacks is 0.24 (in the scale from 0 to 1, 0.24)and when the private and public activities are not separated (answer no=0), the prognosis mean value of terror attacks is 0.82 and positive relations between Variable 40 and Variable 20 (when Vehicle access points to the building is minimized (answer yes=1) the estimated mean value of terror attacks is 0.73, and when Vehicle access points to the building is not minimized (answer no=0) the estimated (prognosis) mean value of terror attacks is 0.33.

Figure 14 Relation between dependent variables (environmental features) and independent variables (number of terror attacks). (Var. 20 Vehicle access points to the building is minimalized; var. 33 public and private activities are separated).

A valuable information, provided by logistic regression analysis, is that variable 33 initially was trying to prove that, if private and public activities are separated, area won't be affected by the threat of

terror. Whereas in fact prognoses shows that, if they are not strongly separated the probability of terror attack is less.

The accuracy of these prognosis is 58.4%. However, it shows results that provide some insights for the future analysis of terrorism targets through urban planning factors.

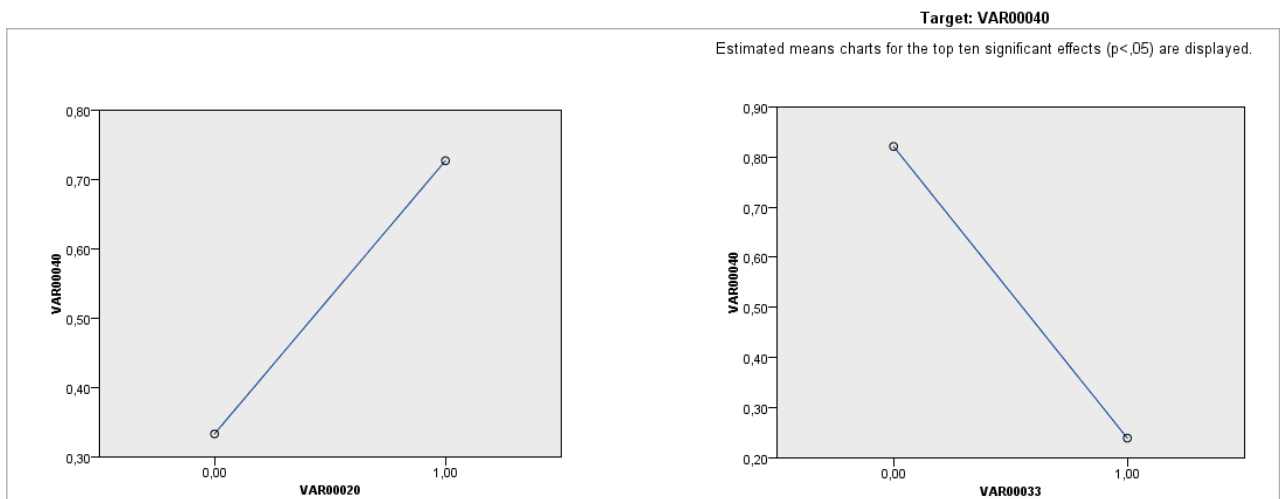As for other variable prognoses. Data is provided for variables 8,30 and 36 (Figure 15).
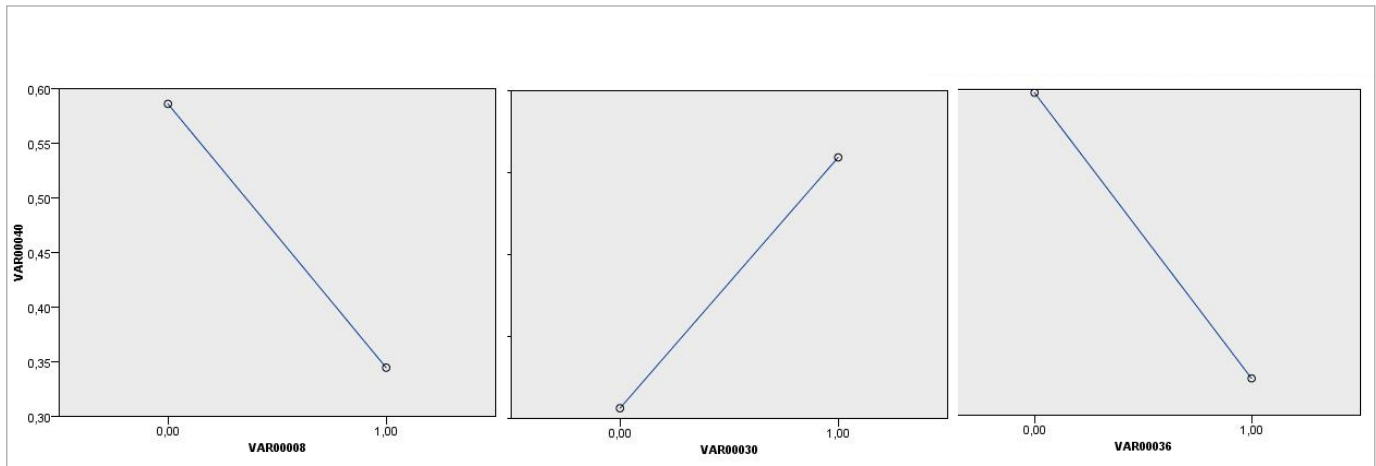

Figure 15 Relation between dependent variables (environmental features) and independent variables (number of terror attacks). (Var. 8 there are multiple entry and exit points to and from the site; Var. 30 there are medical institutions nearby the site; Var. 36 many same functional buildings are redistributed in the surrounding area).

<center>2.4.2. Recommendations</center>

Some recommendations, that are based on case studies, prognosis, correlation, and SS analysis on possible choice of places for terrorist attacks are following:

Recommendations for target selection:

Case studies have highlighted following objects, that is recommended to protect against terrorism. Vulnerable objects are following:

- governmental buildings;
- religious objects;
- tourist attraction spots;
- entertainment and shopping venues;
- transportation hubs;

Recommendations for site reorganization:

- while planning vulnerable sites it is recommended to avoid multiple entrances and exits to and from the site (for both vehicle and pedestrian paths);
- vehicle access points to valuable buildings is recommended to be minimalized;
- public and private activities is recommended not be separated, while planning terror resistant environment, while access to private and public buildings need to be strongly defined;
- in a vulnerable site, many same functional buildings are recommended not to be redistributed in the same area. For instance, avoid planning governmental headquarters and etc.
- parking areas is recommended to be clearly marked and separated from pedestrian walkways.
- it is highly recommended to control all entry and exit points to and from the site.
- it is also recommended to design open space around the building (for increasing standoff distance) and not around the site (for decreeing chance of getting to vulnerable target object with a little effort);
- it is recommended to have both police presence on a vulnerable site as well as medical institution in case of emergency.

Recommendations for street network reorganization:

- it is highly recommended for vulnerable targets not to have a direct access to the main street;
- it also recommended that streets, where a potential target for terrorists is situated, not to have an easy access to the city center;
- streets with high integration level, choice and connectivity values are unprotected against any potential threat, consequently it is recommended they to be reorganized;
- it is recommended to make confusing cul-de-sac roads;
- it is highly recommended to abolish some uncontrolled streets.

CONCEPTUAL MODEL

In search of building up a relevant conceptual model and design strategies, both research parts have taken into account (Figure 16).
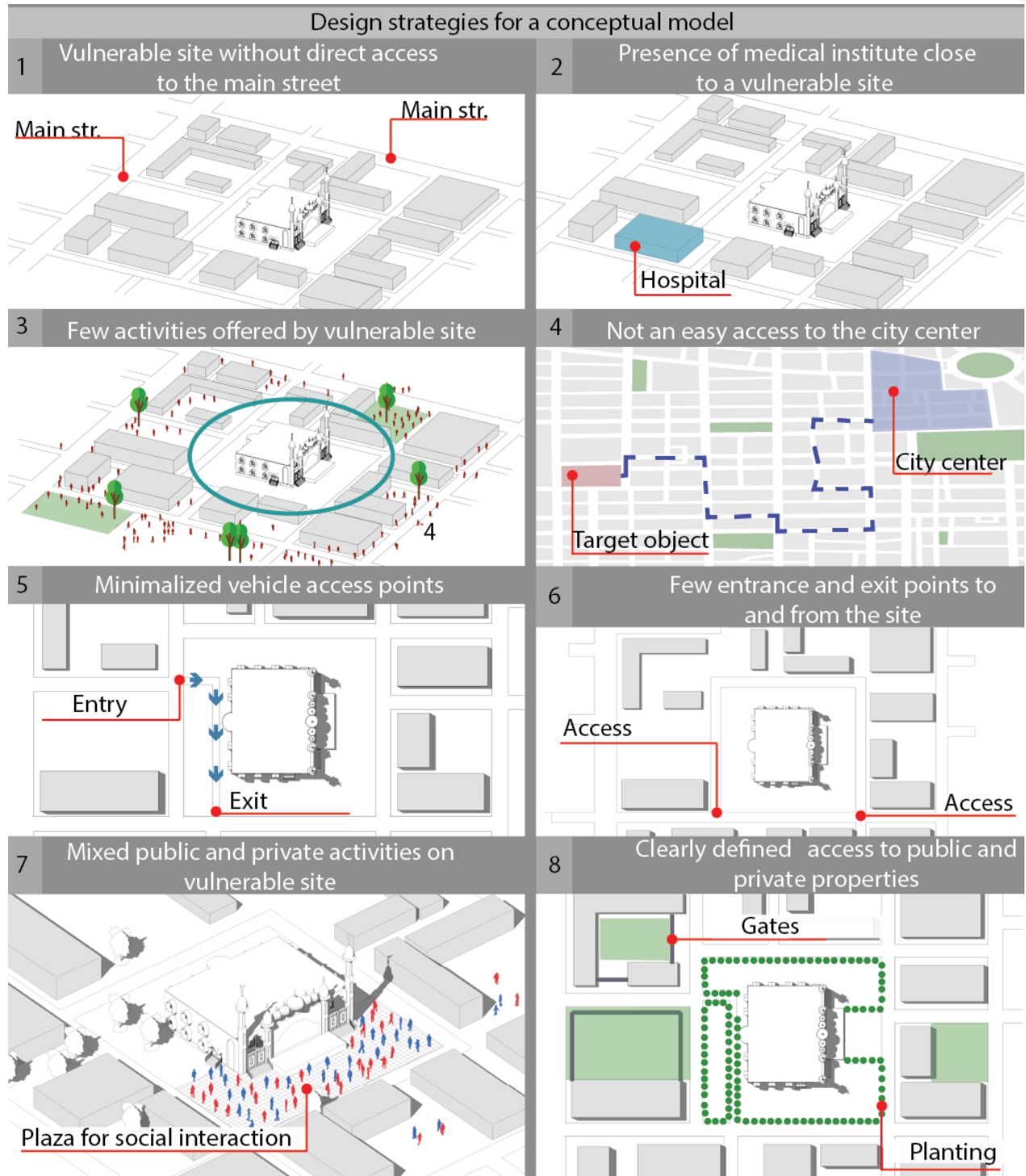

Figure 16 Conceptual approaches and strategies. Illustration prepared by author

In addition to these, two strategical approaches for two recommendations have been developed. Prognoses model from regression analysis, as well as conclusions from case studies have been taken into account. Conceptual model foresees governmental buildings, religious objects, tourist attraction spots, entertainment and shopping venues and transportation hubs as attractive target objects for terrorist, that need to be reinforced with relevant design features, recommended by empirical research results. Conceptual model comprises hypothesis tested for anti-terrorism, CPTED urban and civic design principles and suggests following conceptual approach to the issue of *urban planning and design for terrorism resilient cities* (figure 16):

Starting with the first strategy that is related to a spatial urban structure organization. Findings have proved that street network characteristics can turn a particular area into attractive target for terrorists, with maximum rate of success.

First strategy can be achieved by considering following steps:

- disconnecting some secondary roads from globally integrated roads. Closing them from vehicular access and reload with various activities for increasing urban life in neighborhoods (park/square, playground, weekend community market and etc.)
- turn some secondary streets into one direction streets;
- clearly mark exit and entry points to and from the site and provide vulnerable streets with natural as well as continues surveillance (this approach can be implemented fully or party in problematic urban areas);

Expectation:

- complex and confusing street network systems;
- ease controlled streets;
- redistributed integration and connectivity values to other streets.

Turning into a second strategy that is related to collapsing existing zones and redistributing major buildings in different zones. Even though FEMA guidelines suggests that asset values should be disposed together so as it will be easier to achieve appropriate standoff distance (FEMA 430, 2007), findings have proved opposite.

Second strategy can be achieved by considering following steps:

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- choosing objects for functional exchange by starting evaluating their architectural, historical and cultural values;
- redistributing vulnerable, same functional buildings in different zones (for instance, collapse governmental headquarter and propose some governmental offices in residential districts);

Expectation:

- redistributed asset values leading to more protected 'soft' targets;
- reduced separation between private and public activities.

As for parking lots, that have turned to be one of the most important and significantly correlated with terrorist attack cases, it will be organized far away from vulnerable objects. Either on an empty plot nearby the building or a common parking lot will be implemented in a larger scale.

CONCLUSIONS

Main objectives of Chapter 2 were to test hypothesis and investigate important environmental design features and spatial urban structural forms that can be a determinant factor for choosing specific sites for terror attacks, while avoiding others. Following this, researches have highlighted some key elements. Designing them adequately will irreversibly rise a security level in problematic areas. It can be said that, there are variety of significant conclusions that can be done according to already acquired results from empirical field research.

- According to the fact that thesis aims to rise security level in vulnerable areas, while hiding security design features behind aesthetically pleasant design elements, empirical research hypothesis has formed in order to diminish attack success rate on a site scale, with help of identifying urban elements, rather than architectural features. It tried to identify defenseless roads against terror attacks, also tried to investigate any possible relation between anti-terrorism design features and CPTED security design strategies. For instance: controlled vehicular access points to vulnerable objects, necessity of separated parking lots, importance of natural surveillance and etc. In addition to that it aimed to discover sophisticated anti-terrorism design principles and their strong or weak correlation with terror attack cases. For instance: separated parking lots, implementing anti-terrorism design features (bollards, trees, heavy elements and etc.) in road infrastructure, changes in a zoning plan, separating vehicle and pedestrian flows and etc.

- Turning into summering up results from case studies, has pointed out that in European cities, politically valuable areas are more likely turning into targets of terror attacks. On Asian countries example, religion is the main determinant factor for stimulating attacks. In addition, in last few years, public areas, touristic places and transportation hubs have also been targeted by terrorists. Apart from this, case studies have highlighted that the most common method of an attack is either mass shooting or suicide bombing.

- For urban space arrangement, research concluded that site should not have multiple entrances and exits, as far as it turns the area into vulnerable place. Moreover, controlling multiple exit and entry points is associated with a lot of expenses. Recent studies on terrorism cases, have highlighted the 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 methods of an attack. According to the fact that most major cities are characterized with high density of cars, this factor, can be understood as European cities main problem. However, field research deduced

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that vehicle access points to the vulnerable object should be minimalized. This feature is also associated with CPTED strategy of access control. 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. Another highlighted environmental element is function of buildings and their redistribution in a surrounding area. According to FEMA guidelines, with clear zoning it is easier to achieve sufficient number of standoff distance, in addition to that, it is easier to reinforce complex as a whole unit, better than separate buildings. However, studies have shown that all recent terrorist attacks in Europe happened in districts were same functional buildings are redistributed close to each other. These circumstances can draw conclusions that dispersion of major buildings in a different zone can create extra safety layer and may reduce an asset value of an object.

- Turning into elements of street network reorganization that has been analysed with help of space syntax method. Analyses on cities and sites of terror attacks, pointed out that streets with high integration level, choice and connectivity values are more likely turning into venues of attacks. In other words, it can be deduced that areas that has an easy access, with various combination of road networks that affects road integration values, should be turned into less accessible parts of the city, with complex way of infrastructural reorganization.

- According to logistic regression analysis with accuracy of 58,4%, when vehicle access points to the building is minimalized the chance of terror attack is low. However, when public and private activities are separated the chance of terror attack is quite high. Same prognosis results have variable 36. When many same functional buildings are redistributed in a surrounding are, as well as, when site has multiple exit and entry points, possibility of terror attack is relatively high. As for a variable 30 'there are medical institutions nearby the site' it can decrease a possibility of attacks.

Next chapter will arrange findings, related to anti-terrorism design, combine them with CPTED, urban and civic design principles, so as to be relevant to implement into an experimental project.

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CHAPTER 3

Experimental project for anti-terrorism design interventions in Tbilisi central railway station case

3.1. Background information and factors influencing design processes:

3.1.1. Target object selection for experimental design

According to previous chapters, identifying critical infrastructure is crucially important in order to avoid upcoming hazards and unforeseen causalities. Knowing in advance what to protect, can elude an extreme infrastructural damage, as well as high percentage of victims. Case studies on number of terror attacks in urban structures and in particular, architecture object, has outlined critical infrastructures that need to be protected accordingly. Those are following:

Governmental buildings, religious objects, tourist attraction spots, entertainment and shopping venues and transportation hubs.

The first step of experimental design is identifying a vulnerable site in Tbilisi, a capital city of Georgia, that is being considered as a future potential target for terror attacks in this experimental project (though, there is no relevant information or statistical data to foreseen Tbilisi as a potential target for terrorists). Initially, easy targets, that has been selected from previous researches has been marked on Tbilisi city map:

- Governmental headquarter on Freedom square;
- Boris Paichdze Dinamo Arena;
- Main religious building: Sameba cathedral
- Transportation hubs: Tbilisi Central Railway station, Vagzali square; Tbilisi international airport.
- Tbilisi International Airport;

In order to identifying importance of particular streets that could be a potential terror attack venues, space syntax visual analysis have been carried out. For discovering urban features that can be a cause of vulnerability of a particular territory, following major space organizing attributes have taken into account: connectivity, choice and integration (mean depth attribute was ignored in target selection process, as far as it did not give us a significant result in a precious researches). Syntactical analysis identified Tbilisi street network pattern and people's movement, determined by spatial urban structures. Tbilisi has been analysed in a similar way as Ankara, Tel-Aviv, Istanbul, Brussels (Figure 16)

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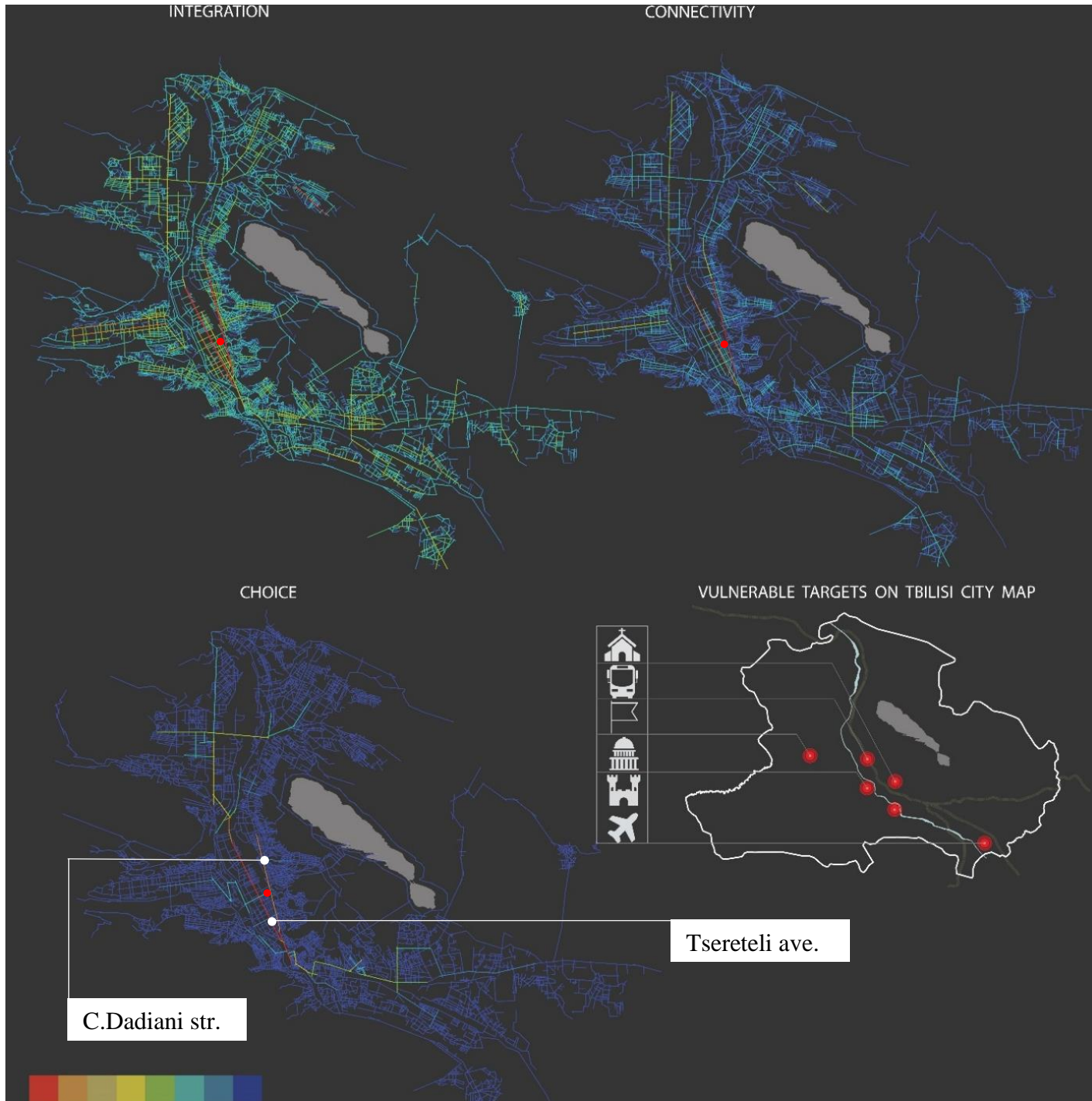
Figure 16 Tbilisi city map syntactical analysis and highlighting possible vulnerable targets for terror attacks
Warm color (Red, orange, yellow) lines mean the highest values of integration, and cold color (blue, green) lines mean the lowest values of integration. Red dot designates railway station. Illustration prepared by author

However, in a chapter 2 empirical research part 3, SS analysis were carried out for the reason of

identifying spatial urban structure factors, that influence choice of places for terror attacks, while in

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chapter 3, SS method is used to compare potential vulnerable targets in the city by means of their spatial patterns and identify most critical streets of Tbilisi and closely disposed potential vulnerable target. According to the Figure 16, Tsereteli avenue, located horizontally south-east towards the railway station and north-west road C. Dadiani street has a high connectivity, integration and choice values. (Figure 16)
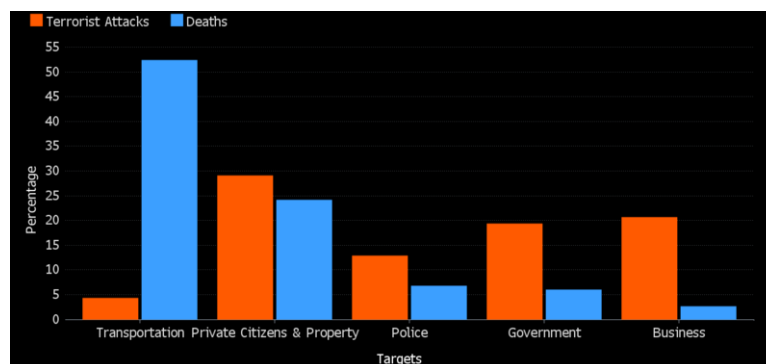
Looking through recommendations, developed in a previous research, globally integrated streets with high values can turn the site into a vulnerable and a potential target for terror attacks. According to this, Tbilisi central railway station has been selected as an experimental design object for a thesis work.

Apart from above mentioned determinant aspects, there are number of factors that should be taken into consideration. One of the most significant is the number of concentrated population and site users on railway station and surrounding territory.

Another factor, that on itself determined choosing Tbilisi for implementing strategies and recommendations from previous researches, is that currently city is going through redevelopment processes. In details, Tbilisi city hall is working on a new zoning plan for the city. This circumstance gives us a possibility to change zoning in railway station site and suggest new approaches that could solve the problem of vulnerability.

In order to reinforce decision on site selection, thesis provides relevant statistical data, that highlights difference between the impact of an attack in five urban forms: transportation hub, citizens/property, police, governmental buildings and businesses. From which, attacks on transportation hubs can lead to high number of casualties. (Figure 17)

Figure 17 2014 statistical data of terror attack sites and causalities. Source: Global Terrorism Database, maintained by the National Consortium for the Study of Terrorism and Responses to Terrorism at the University of Maryland and Bloomberg analysis.

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3.1.2. City infrastructural reorganization and public transport mobility on the site

Starting with Tbilisi road infrastructure and its relation to the research object_ Tbilisi central ailway station. According to Figure 18, roads next to the railway station is one of the most important collector roads in the city, that on itself characterized with a high value of connectivity, integration and choice values (Figure 18).
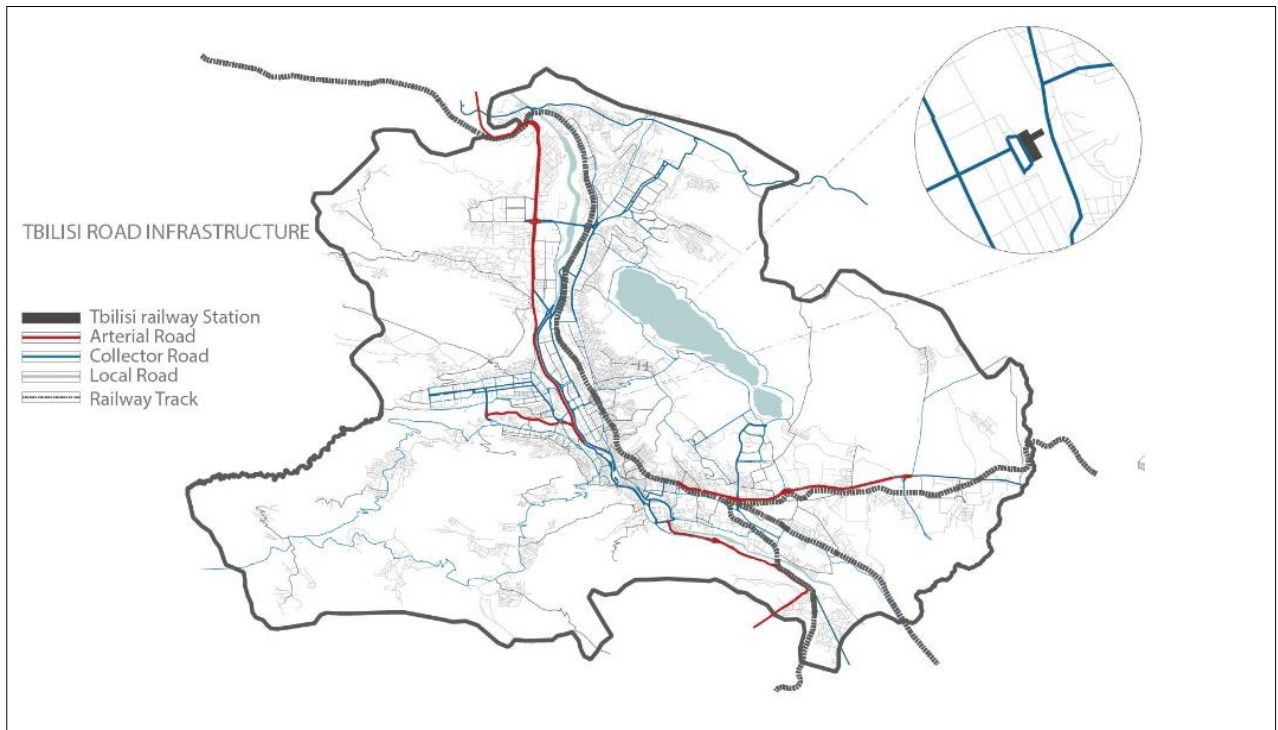
Figure 18 Tbilisi Road Infrastructure, classification arterial, collector and local roads. (Prepared by author)

Turning into major city exit and entry points, Tbilisi has 5 major entrance and exits to and from the city, connected with main arterial roads. (Figure 19) In addition to this, there is also 20 alternative exit and entry points that are used rarely compared to those 5 major highways (Source: Tbilisi Transportation Company).
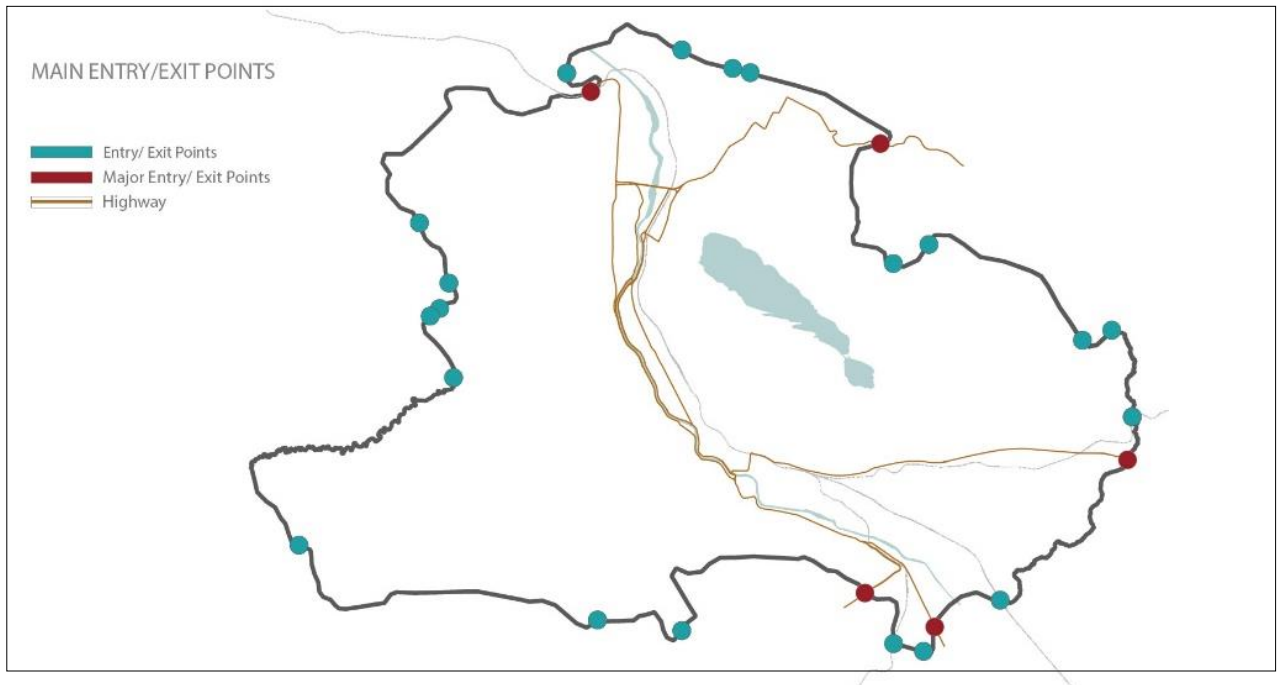
Figure 19 Main entry and exit points to and from the city. (Illustration Prepared by author)

It is a significant fact to be mentioned that, Tbilisi central railway station can be understood as one of the major part of a multifunctional complex site. However, apart from train and long-distance commuters, site is also loaded with daily users of various means of public transportations. In details, railway station site is presented by major bus stops, mini bus stations as well as metro line intersections. It is relevant to mention here that according to the data, provided by GeoStat (Georgian Statistical Center) analysis on public transport user's statistics from 2016, busses are most popular public transport solution with 363,2 million passengers per year. After bus, metro annually has 102.9 million users. (Figure 20)

It also should be mentioned, that site comprises main intersection of underground subway *Station Square,* presenting with 3 entrances and exits, that directly connected with railway station ensemble (Figure 20). Subway is one of the main and the most flexible means of public transportation for Tbilisi citizens, especially after the sprawl of the city to peripheries, it has turned into the fastest and the most convenient connector of suburban areas to the city center, characterized with a huge number of daily users. Initially, it started functioning with 5 metro stops (Didube, Electrodepo,

Vagzali Square, Marjanishvili and Rustaveli) in 1966. Nowadays, presented with 22 stops (Figure 20).
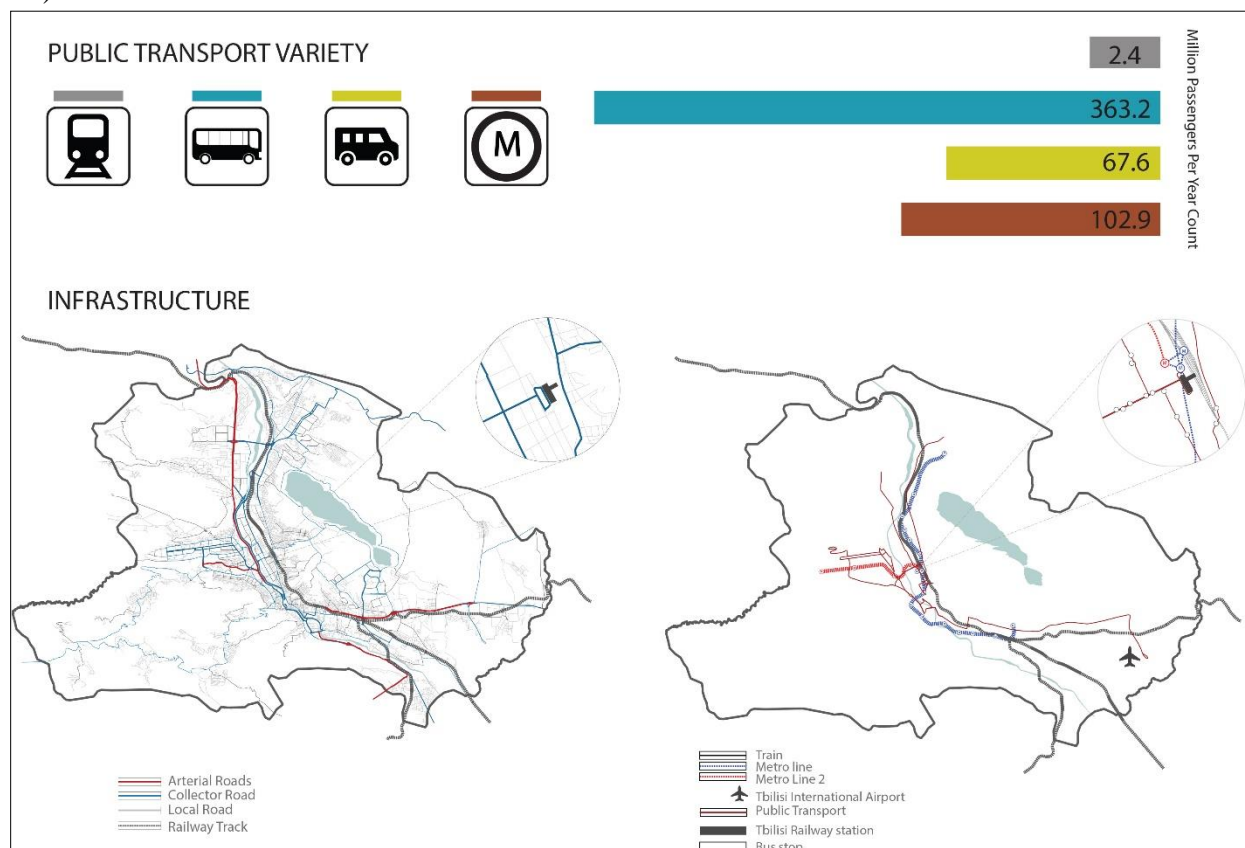
Figure 20 Public transport variety and statistical data Source: GeoStat, Illustration prepared by author

In addition to this, with monumental plazas in front of almost all metro entrances, it is a venue of a chaotic, irregulated outdoor trade (figure 21).

Figure 21 Plaza next to Vagzali square metro station. Source: Newspaper რეზონანსი (RezonansiAs

As for mini bus stations, it is spread all over the site, occupying plazas from both entrances. This chaotic configuration, following with unorganized flows of people, rises the importance of regulating different functional zones in a way to make controlling site with natural, as well as, continues surveillance possible (Figure 22).
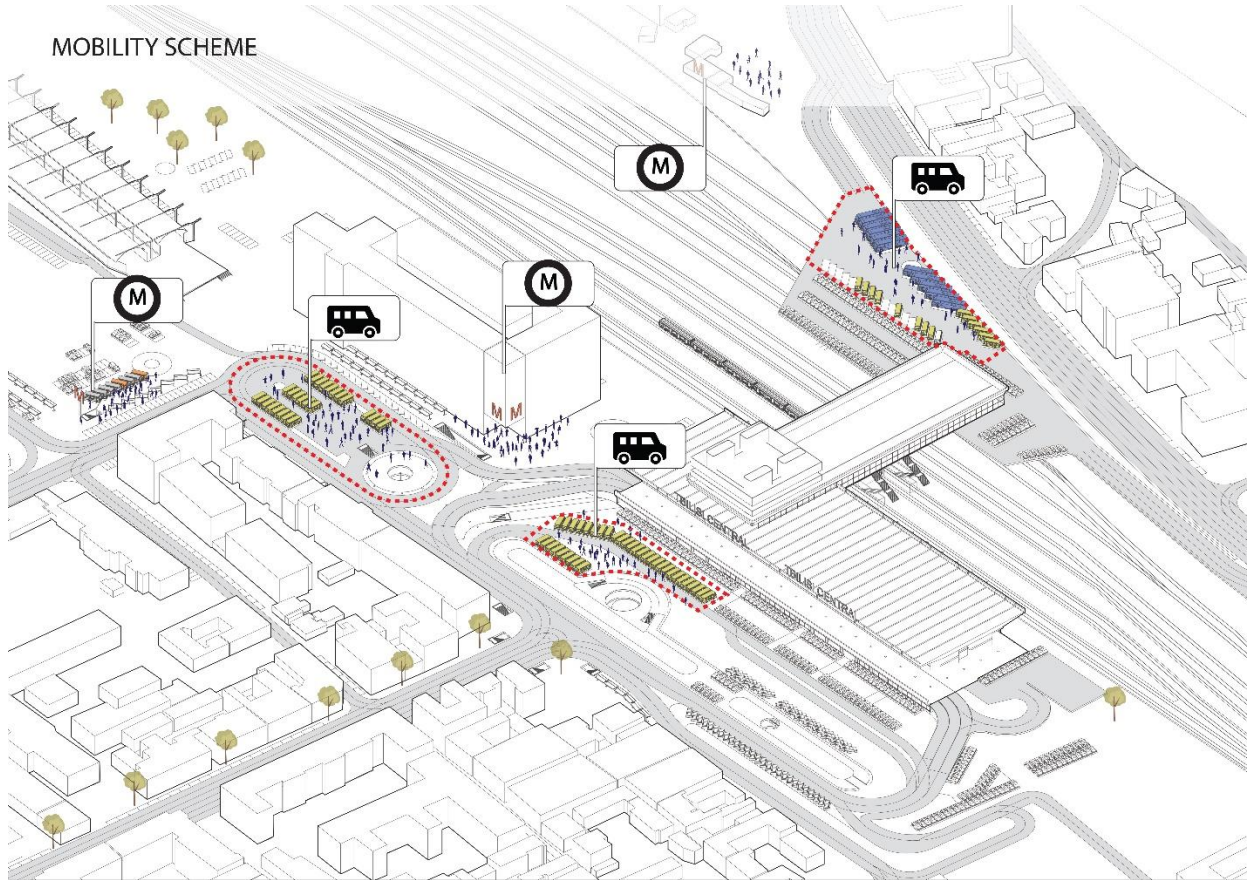
Figure 22 Redistribution of Metro and Bus station on the site. Existing situation (Illustration prepared by author)

Turning into major bus stops, it is significant to be mentioned that 6 main bus stops are located in front of main entrance of central station. According to urban planning principles, this circumstance ensures accessibility to the site that can be understood as an advantage of the site as well. Although, it rises vulnerability rate of a complex, as far as busses has a relatively close access to the building without monitoring (Figure 23).
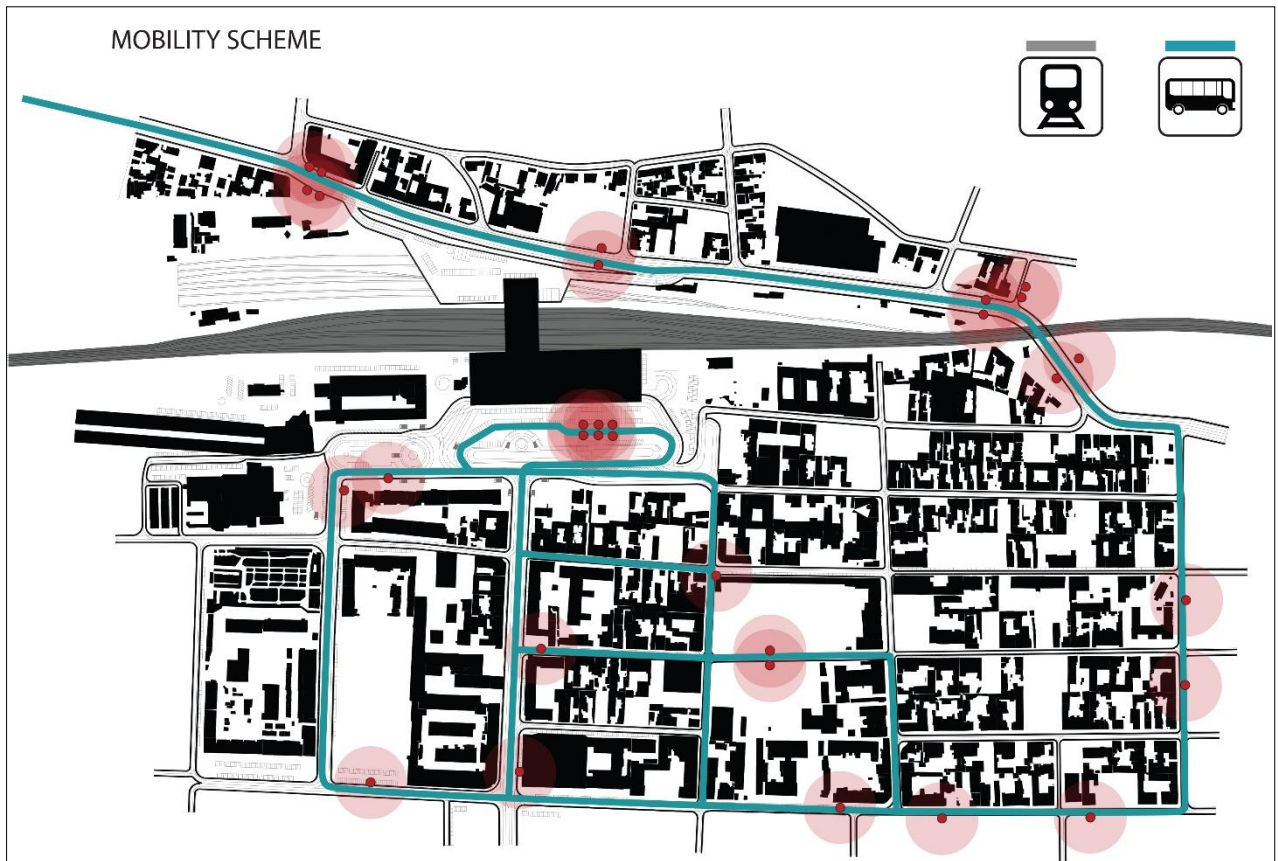
Figure 23 Scheme of major bus stops. Prepared by author

3.1.3. Irregular Parking lots

Turning into one of the most important issues of the area, parking lots density and traffic congestions, caused by the growth in number of private means of transportation. According to the data, officially registered cars in Tbilisi, makes up to 1.1 million, almost the same as the number of inhabitants, from which 100 000 cars has been counted on a daily street traffic (data provided by the National Statistics office of Georgia). This circumstances, lead to the lack of parking lots and uncontrolled streets, where Jane Jacobs 'eyes on the street' theory is hard to be fulfilled, either with continuing or natural surveillance. On another hand, "controlling vehicle speed allows more time for surveillance, and it decreases the kinetic energy of a vehicle, thus lessening the resistance strength needed for a vehicle barrier." (Peart, 2000) In this case, it is possible to use existing urban characteristic features offered by the site itself and turn them into elements of protection.

Notwithstanding, presented parking organization in Railway station site, has no consideration of either anti-terrorism design, nor CPTED or urban design principles. There is no clear division between parking lots used by the visitors of the site and workers in the railway station. In addition to that, mini busses and busses for international and national routes has no separate plazas, leading to uncontrolled crowds of different facility users.

Railway station parking lot is one of the main determinant factor of turning the building into an easy target for terrorist, by means of not existence of decent amount of perimeter control barriers (Figure 24).
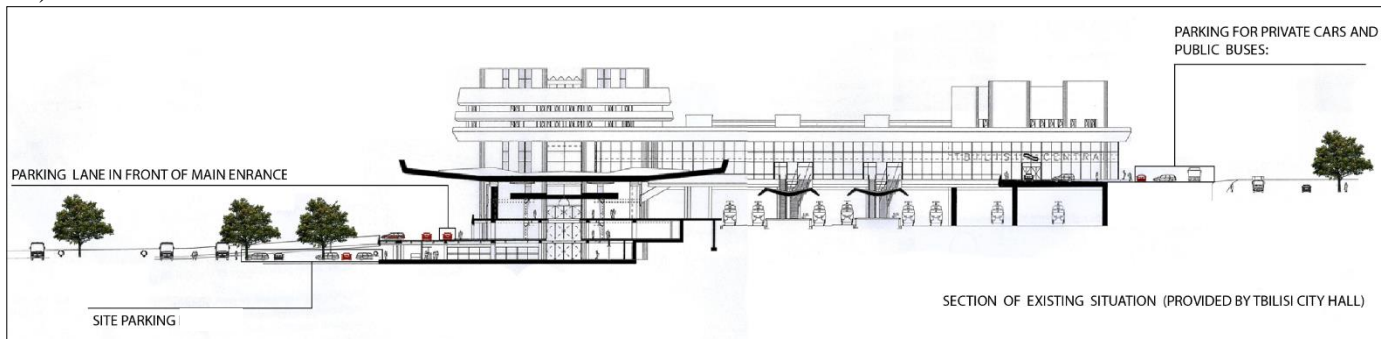
Figure 24 Railway station section, illustrating existing situation of parking reorganization on the site; Source: Tbilisi City Hall

3.1.4. Destination of shopping

Outdoor irregular trade has always been a drawback for the city of Tbilisi, arising number of social and economic problems. Historically, shopping directly on streets, has a medieval root. It has been emphasized in 21st century and now almost identifies as the characteristic of all contemporary cities. Accordingly, it is quite common to see illegal shopping close to transportation hubs, bus and metro stations and etc. (figure 25). As has been mentioned in previous subparagraph, plazas next to the Metro entrances, have been occupied by traders, that on itself reflected into high concentration of people, users of subway and shoppers. It is a vivid fact that, this circumstance turns public places into chaotic areas. Neither natural nor continuing surveillance is possible, leading to unsecured crowded places and vulnerable targets for terrorists respectively.
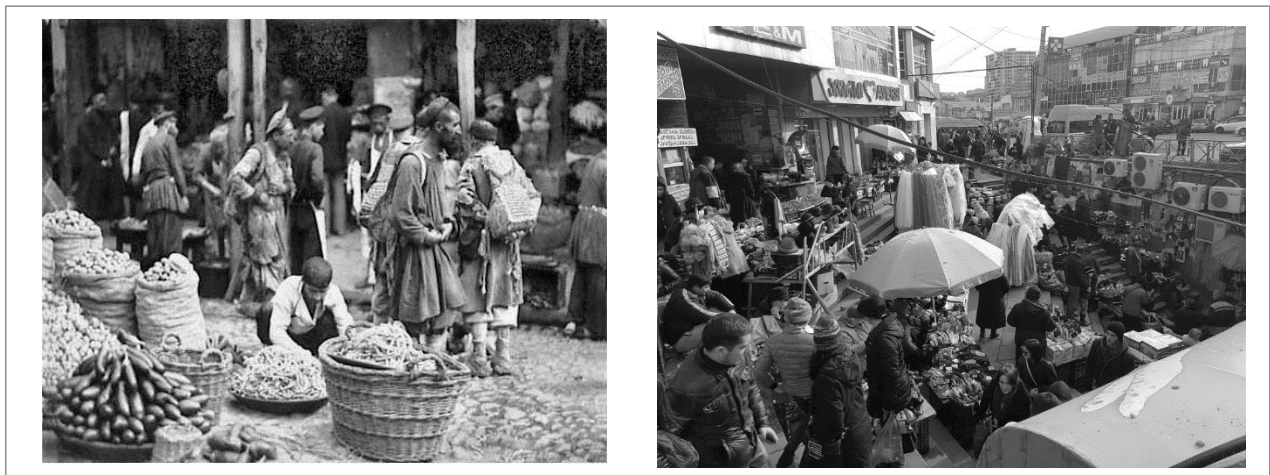
Figure 25 On the left old Tbilisi Bazar. Source: national archives of Georgia. On the right current situation, Axmeteli metro entrance. Photo taken by author.
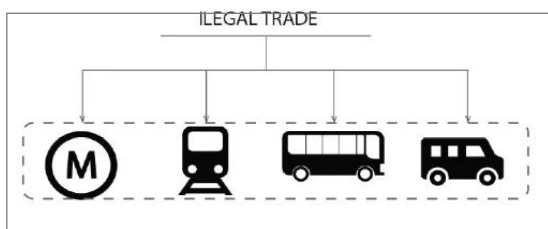
Figure 26 illegal trade and its association with city transportation infrastructure. Illustration prepared by author.

Turning into a Vagzali square, that vividly facing up with problems, caused by uncontrolled under and over ground traders. Illustration of shopping classification in Vagzali square could be following (figure 27).
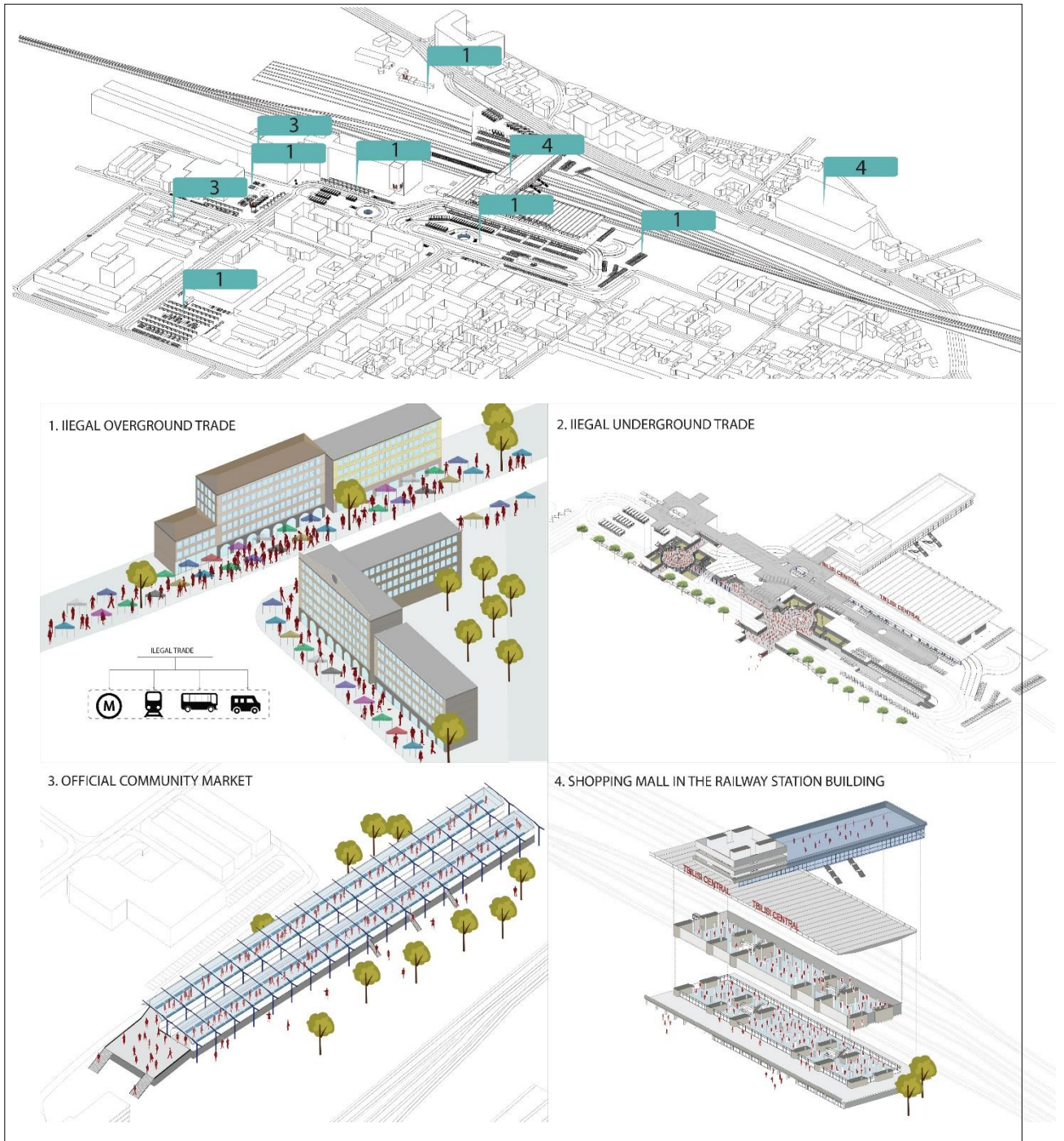
Figure 27 Typology of trade and its location on a site 1) illegal over ground trade; 2) Illegal underground trade; 3) official community market; 4) shopping mall in a railway station building. Illustration prepared by author)

3.1.5. Community context and urban life

Literature analysis in a chapter 1, has highlighted the importance of considering community context while creating safe environment for civilians. Ignoring urban life while rising safety on the site, most probably will lead to 'failed spaces'. Analysing existing program on the site, has shown that, there is a lack of facilities that can be used by civilians. Presented urban life is poor, with scattered facilities without any strong connections (Figure 28).
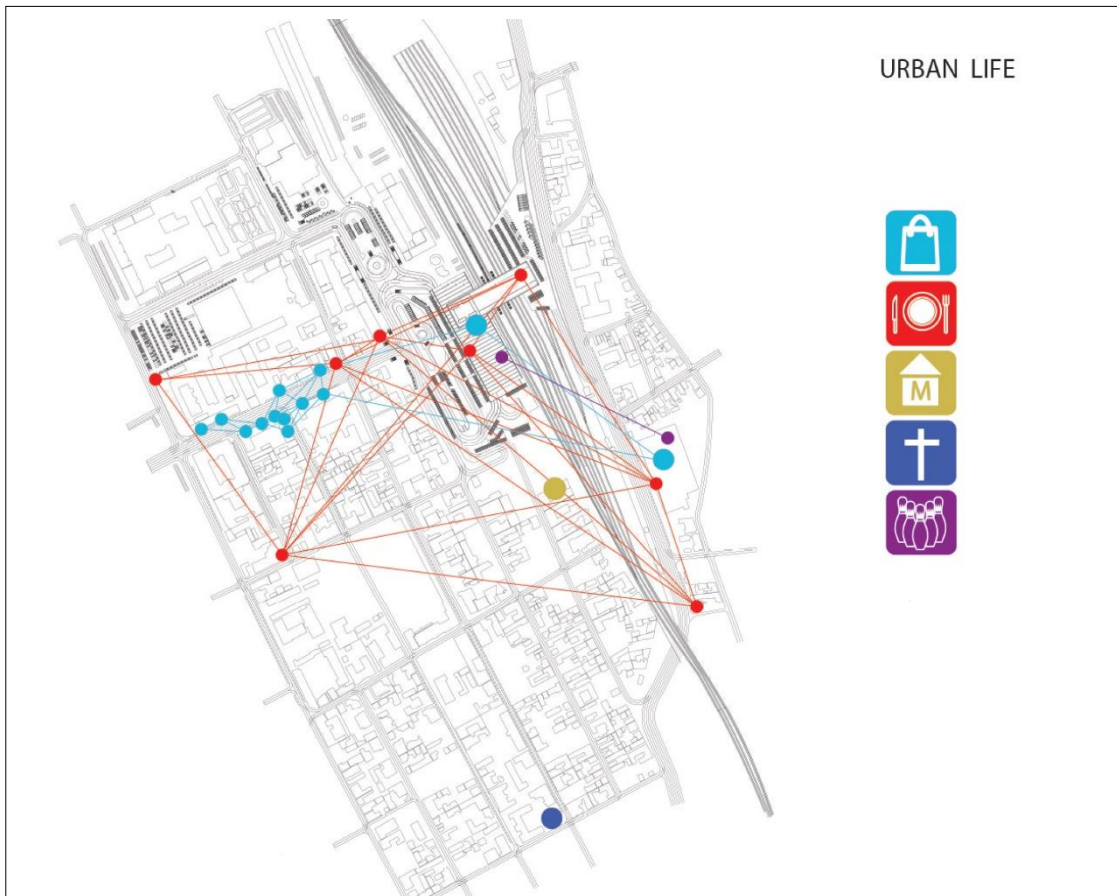
Figure 28 Urban life and public facilities on the site. Illustration prepared by author

According to the figure 26, territory has almost no venue of entertainment. In conclusion, here can be said that site only offers an easy transportation facilities and provides a various shopping opportunities for its users. Shopping facilities obliquely associated with transportation respectively.

3.2. Research on the data necessary for design:

3.2.1. Methodology of acquiring relevant information for design feature implementation

Acquiring data necessary for design has been carried out by different methods and approaches. Important data has been provided by various organizations. Starting with calculating number of inhabitants in 200-meter radius (minimum evacuation distance) has been achieved with ArchGIS software by National Statistics Office of Georgia(GeoStat).

Data related to number of busses and mini busses has been provided by Tbilisi Transport Company. Tbilisi transport company also provided information related to number of passengers from all three exit and entry points of Vagzali Metro station.

The weakness of experimental design methodology is determined by not existing any official organization, possessing statistical data of traders and shoppers on the site. This circumstance is mainly determined by its illegal status.

Turning into the methods of building up an existing site model, has been achieved with help of documents provided by National Archives of Georgia, comprising plans of underground passing's next to the railway station. As for Tbilisi City Hall, provided topographical and zoning maps of Tbilisi as well as existing Railway Station project documentations (plans, sections, facades and etc.).

As has been mentioned in a previous sub-paragraph quantitively research on railway station site users is general. However, it can give us an overview on probable number of causalities in case of any possible attacks. Data acquired with help of ArcGIS shows that in 200-meter radius (where starting point is Tbilisi central station building itself) static number of inhabitants is 3112 persons. Turning into data related to Vagzali metro station three entrance user's calculations are following (table 5; figure 29):

Date	Week day	Entrance 1	Entrance 2	Entrance 3	Sum
03.10.2016	Monday	19460	10686	9762	39908
03.10.2016	Tuesday	18892	10910	9854	39656
03.10.2016	Wednesday	20196	10779	10061	41036
03.10.2016	Thursday	18967	10690	10342	39999
03.10.2016	Friday	18853	10463	9971	39287
03.10.2016	Saturday	13963	6973	7397	28333
03.10.2016	Sunday	15778	6518	8249	30545

Table 5 Station square passenger's calculation (3 entrance count) from October 3rd, 2016, Source: Tbilisi Transport company
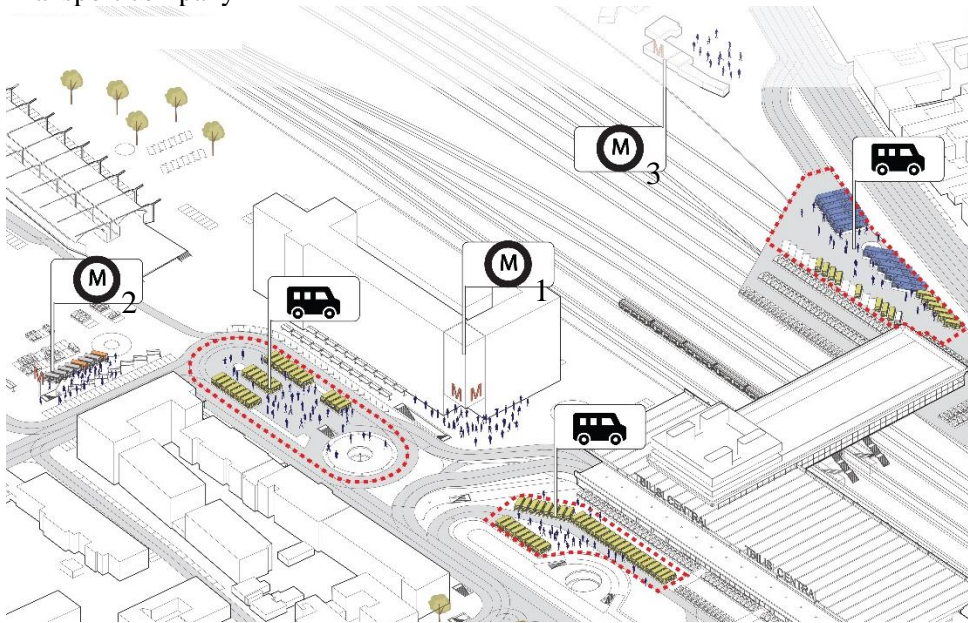
Figure 29 diagram of a site with marked 3 metro entrances and public bus locations on railway station site. Illustration prepared by author

Turning into the number of public bus and mini bus users in experimental design site is following (Table 6)

Date	Quantity of buses	Quantity of trips	Total number of passengers
Tuesday/Saturday/Sunday	262	959	69223

Table 6 Quantitative data on Station square busses and mini buses. Source: Tbilisi Transportation Company

3.2.3. Tbilisi historical layers and railway station site formation

Tbilisi, a capital of Georgia, geopolitically abutting countries like Armenia, Turkey, Azerbaijan and Russia, has never been a destination of terror attacks. Even though it is located in central Asia, its urban structure is more related to European city patterns. Apart from this, city has gone through a migration flows from neighborhood regions, presented with 1.1 million inhabitants whereas in fact total number of civilians in a country is 3.7 million. (Data provided by Tbilisi City hall)

In the middle of XIX century when train tracks have appeared in the city, Tbilisi started a rapid growth alongside the train line and a major core, Mtkvari river. It is a significant fact that the right bank of the river has been growing immensely compared to the left side, that was mainly caused by the importance of new railway station (Figure 30).
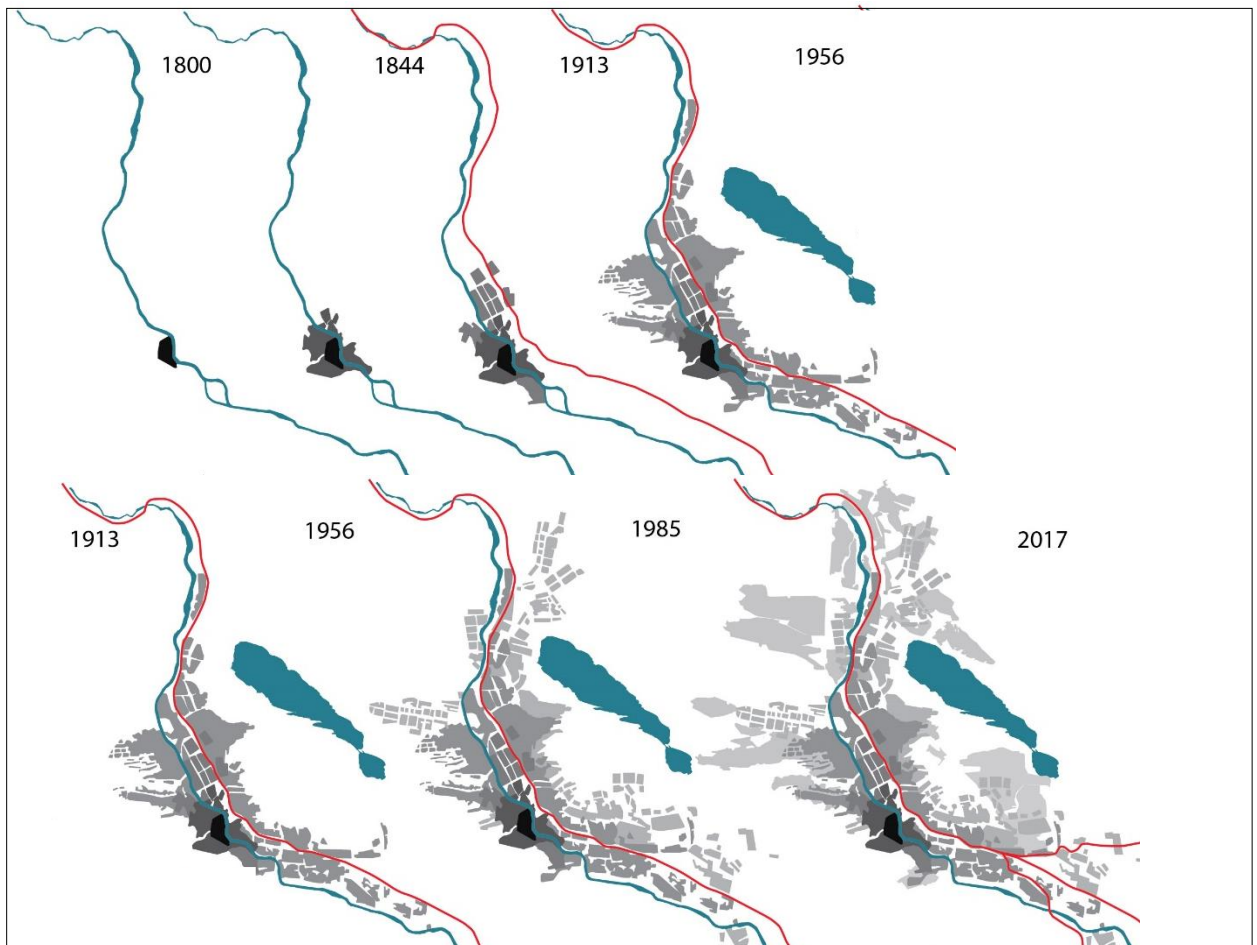
Figure 30 Tbilisi formation from 1st half of XIX century until Now, highlighting importance of new railway station. Train tracks marked with red, Mtkvari river marked with blue. (prepared by author).

As for, Tbilisi railway station history, it dates back to 19th century. Original building was surrounded by a wide plaza, accessed by phaetons. During this time, infrastructure on the site has been formed, as well as the initial ideas of zoning has been developed, leading to a formation of regulated urban network. During this time, King Tamar street was narrow and insignificant, however in the middle of 20th century, it has become a strong core of the site as well as of the city (figure 31, figure 32). As for formation of residential districts in a surrounding territory, has not started until 20th century. Development of a new community was mainly determined by industrial revolution, following with reconstruction of significant number of factories that had been appeared around station building.
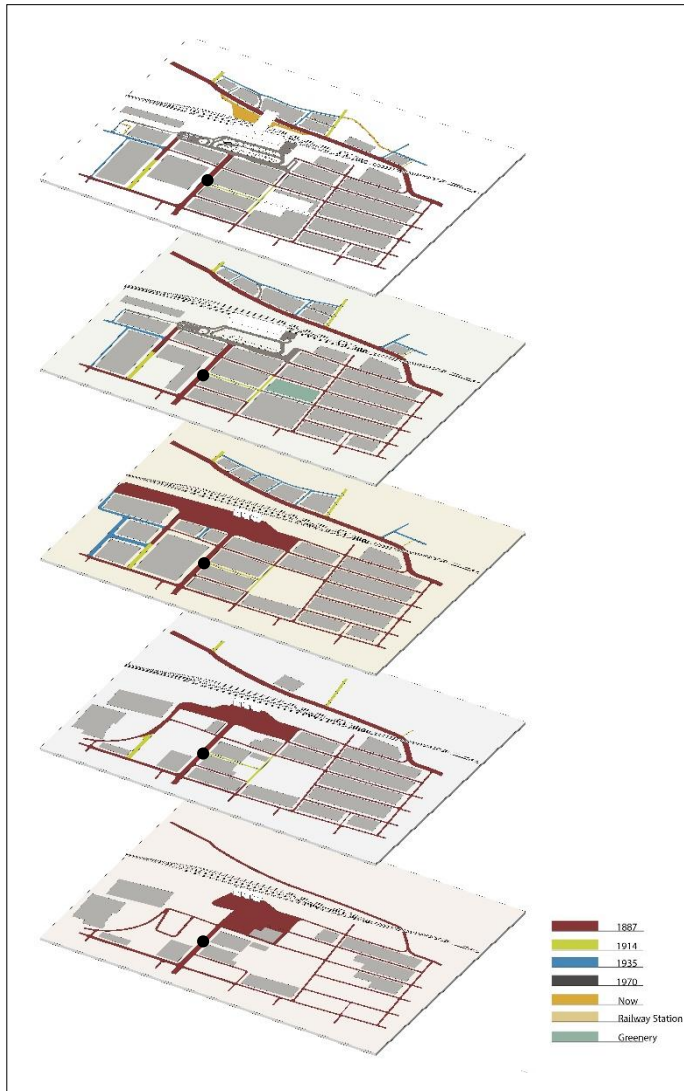
Figure 31 Historical layers of site formation. K. Tamar street marked with a black dot. (Illustration prepared by author).

During soviet times in Georgia, building has been reconstructed to better suit 'Stalinist' epoch. Consequently, in 1982, building and surrounding site has changed dramatically once again (figure 31, figure 32). However, reconstruction processes procrastinated with the reason of Soviet Union collapse. Building had been occupied by refugees between the years 1992 and 1993.

In 2008, new site reconstruction strategies have been developed. Idea was to strengthen connections between two sides of railway tracks, expressed with new building configuration.

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Station building has been extended over railway tracks, serving railway station purposes. As for main building, it has been occupied by city's main shopping hall. During this times, most factories have become abandoned or turned into residential buildings.

| 1887 | 1914 | 1970 | 2017 |
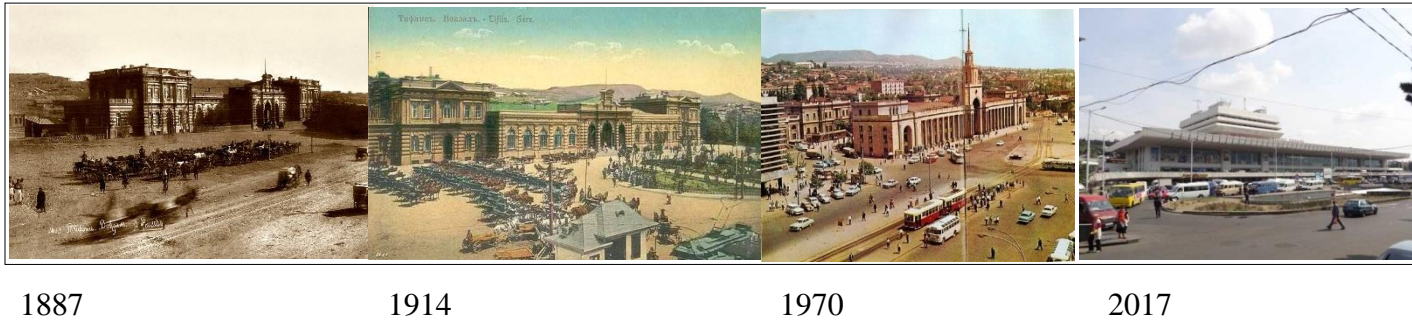
Figure 32 Historical pictures of railway station and its surrounding territory formation (Source: national Archives of Georgia)

According to the data provided by Tbilisi City Hall architecture office, major part of the railway station territory, comprises commercial zones, mainly determined by the fact that site is reloaded by transportation zones.

Figure 33 shows, that a site has the lack of greenery and public open spaces. On one hand, this circumstance could be beneficial while keeping in mind anti-terrorism design and previous case studies, that showed that public crowded places are more likely turning into targets of terror attacks than reinforced so called 'hard targets'. On another hand, avoiding public realm and ignoring public requirements, while concentrating only on security design, will irreversibly leads to spaces that are not used by people adequately.
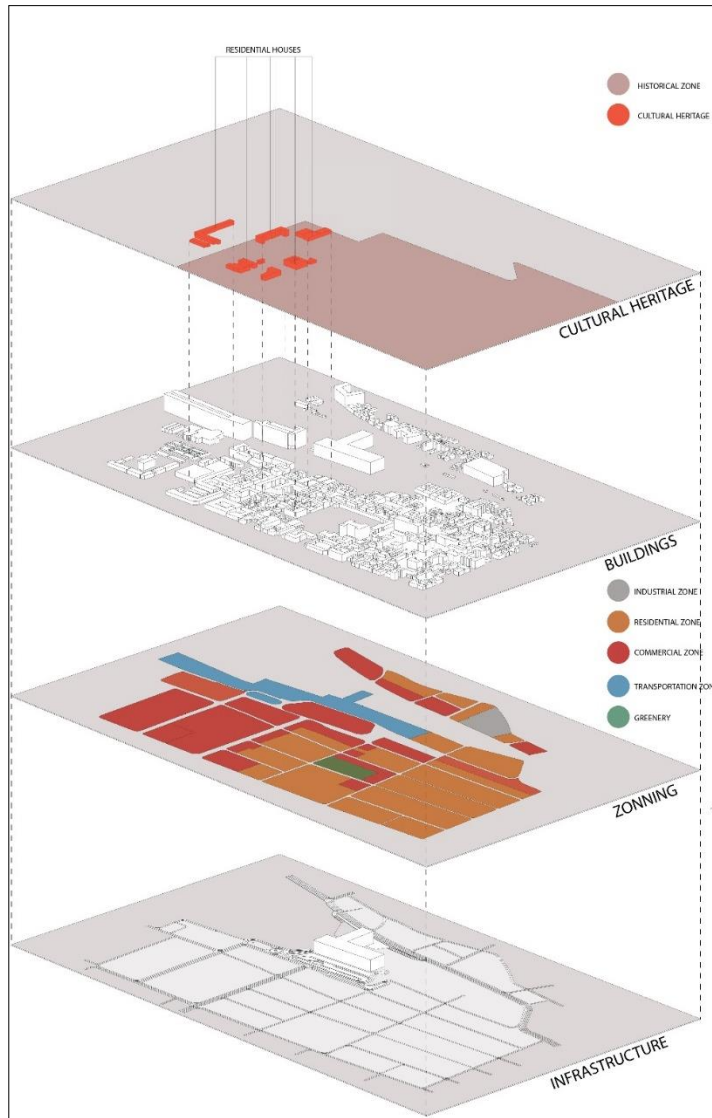
Figure 33 Zoning and site's existing situation. Source: Tbilisi City hall, illustration prepared by author

To conclude here, current situation in Vagzali square is characterized by uncontrolled flows. Site is used only for transportation and commercial purposes.

3.3. Conceptual approach to the issue of Railway Station reinforcement and design implementations:

3.3.1. Civic, urban design, CPTED and Anti-Terrorism design principles and the ways of consideration into railway station case.

The necessity of collaboration between disciplines such are: urban design; crime prevention through environmental design and anti-terrorism design, has been highlighted in a chapter 1 of a thesis work. Although, chapter 2 tried to humanize anti-terrorism design strategies, by concentrating on environmental design (CPTED) features and spatial urban structure factors. It is relevant to mention that, "you can increase security to a point where you actually install fear, and then you have failed spaces" (Hockenberry 2006). According to this, spaces fail, when people are too scared to use it adequately. In most cases, following anti-terrorism design guidelines offering solutions without taking into consideration of primitive placemaking principles. Reinforcing building with blast resistant materials, putting up fences and closing ground floors for public with help of not really welcoming facades. On one hand, new findings (from chapter 2) with cooperation of CPTED security design principles will inevitable optimize safety and security of a public place, through some interventions. On another hand, considering only security design aspects, will inevitably have a negative influence on creating places for daily users and their typical behaviors. According to this civic and urban design principles should also be taken into account. Experimental design for terrorism resilient cities aims to balance those design principles. Starting with finding common features for all three (table 7_1; 7_2; 7_3; 7_4; 7_5; 7_6).

Table 7₁ CPTED, anti-terrorism design, urban and civic design principles optimization for design.

Element	CPTED goal	Anti-terrorism design goal	Urban planning and civic design goal	Ways of implementing in Tbilisi railway station design
Limited entry and exit ways	According to CPTED strategies, there is no limitation in number of exit and entry points. Though, it suggests special design for doorways. For instance: appropriate lightings, monitoring with CCTV cameras and etc.	Limited entry and exit points to and from the site will ensure monitoring potential criminals.	It can have a negative impact on accessing the site by both pedestrians and vehicles.	In a district scale, experimental project strategy is to clearly distinguish entry and exit points, abolish some unused streets for traffic flows while opening them up for public realm.
Redistribution of many same functional buildings	N/A	Governmental districts, cultural districts etc. can turn into an easy target for terrorist organization, as far as same functional buildings are redistributed in the same area.	Redistribution of many same functional buildings in the site, makes it easier and clear for visitors to use the space. Same functional building concentrated only on one space, may create identity for the area itself.	Experimental project will disperse the importance of existing program on the site. It will abolish outdoor trade next to railway station and will create alternative and appropriate places for weekend market, away from railway station in a residential zone.
Clearly defined access to private and public space	"Natural access control is one of the CPTED strategies. It is accomplished by the design of streets, sidewalks, building entrances, and neighborhood gateways to mark public routes, and by use of architectural and landscape structural elements to discourage access to private areas. So as to be visually different from open public space access" (FEMA 430) .	Finishes and signage should be designed for visual simplicity.	N/A	Experimental design has no specific implementation of this principle. Private properties in this case, community housing has controlled entrances inside courtyards and the building itself with reinforced doors.

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Table 7₂ CPTED, anti-terrorism design, urban and civic design principles optimization for design.

Element	CPTED design goal	Anti-terrorism design goal	Urban planning and civic design goal	Ways of implementing in Tbilisi railway station design
well used site	well-used and well-maintained streets and sidewalks are safer compared to empty spaces. Both natural surveillance and territoriality can be achieved by promoting more activities in public spaces. (Jane Jacobs 1961)	Well used site means it has many visitors. Crowded places are always hard to control, consequently this circumstance can turn it into an unsafe place and an attractive target for terrorists.	One of the main objectives of urban design is to turn places into an attenable and well-used spots for locals as well as for site visitors.	As far as, Railway station plaza and surrounded territory is reloaded with multiple activities, whereas in fact parallel streets is being used just by residents, experimental design proposes to create interesting spots in surrounding territories as well, while abolish some activities such as outdoor trade next to railway station plaza and underground pathing's.
Direct access to the city center	N/A	When site has a direct access to the city center or located in the city center, its valuable properties are higher. Site that has a direct access to the city center, could be easier for terrorists to plan their attacks.	Site, having a flexible connection to city center leads to well-used and attend able places.	This recommendation could be considered while designing new building, in this case, only consideration in experimental project could be controlling vehicle access points to and from the site.
Separated public and private activities	All areas are designated as either public, semi-private or private. This designation defines the acceptable use of each zone and determines who has a right to occupy it under certain circumstances. (Security management magazine 1981)	Accesses to public and private buildings should be defined. However, research findings have shown that, when activities are separated chance of an attack is high.	Private areas should be defined by small fences and site boundaries	Experimental design will suggest semi-private transitional zones from public to private spaces. For instance, new residential housing complex will suggest services for its residents as well as site users. Same can be said about reconstructed new office building ground floor that will be open for public uses.

Table 7₃ CPTED, anti-terrorism design, urban and civic design principles optimization for design.

Element	CPTED design goal	Anti-terrorism design goal	Urban planning and civic design goal	Ways of implementing in Tbilisi railway station design
Site location on globally integrated streets.	"Properties on development with high levels of connectivity through movement, experience more crime." (Bevis and Nutter 1977; Rubenstein et al 1980; Taylor and Gottfredson 1987 Van der Voordt and Van Wegen 1990; White 1990; Poyner and Webb 1991; Beavon et al 1994; Mirlees-Black et al 1998; Rengert and Hakim 1998; Hakim et al 2001; Taylor 2002; Nubani and Wineman 2005; Yang 2006; Armitage 2006; Armitage et al 2010)	Site location on globally integrated streets with a lot of connector roads may turn it into a vulnerable target for upcoming terror attacks.	"The route should be integrated within the urban fabric so that a sense of place is maintained and to prevent severance between adjoining areas." (The Design Manual for Urban Roads & Street, 2013)	Disconnected some roads from k. Tamar str. Closing them for vehicles and turning them to pedestrian roads. Same actions should be done on Dadiani str.
Minimalized vehicle access points to the building	One entrance is acceptable, but blocking exits is impermissible due to fire safety or other issues.	Preferred to be limited both entry and exit ways to better screen for terrorists	Limited entry and exit ways can cause devaluation of a particular areas	Entry and exit points should be clearly defined and controlled with continuing surveillance (CCTV cameras).

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Table 7₄ CPTED, anti-terrorism design, urban and civic design principles optimization for design.

Element	CPTED design goal	Anti-terrorism design goal	Urban planning and civic design goal	Ways of implementing in Tbilisi railway station design
Direct access to the main street	Site location on main street rises its valuable properties and importance among site visitors.	Direct access to the main street can raise the risk of terror attacks. (This principle can be considered in initial projects)	Site located on the main street guarantees its potential developments and capacity of the area.	Disconnecting K. Tamar street that has a direct access to the railway station plaza from the site.
Bollards	Neighborhood ownership; Barrier for visual permeability; Protects pedestrians from cars;	Ensures security of a territory; Increase a standoff distance; protects pedestrians and important facilities from direct vehicular penetration.	Right selection of bollards, reflecting characteristic feature of an area; Can have multiple uses other than ensuring security level;	Creating own bollard design for using as a bench; Using bollards for blocking traffic flows on streets that has been proposed to be closed for cars; Using bollards to distinguish pedestrian lines from traffic lines in a high-speed area;
Planting	It shows the ownership on a particular territory. Acts like a natural fence. Guides visitors to desired entrances and away from private areas. (General guideline for designing safer community January 20, 2000) High trees may remove the ability of natural surveillance from lower levels of the building;	Planting can act like a barrier prevent potential criminals from obtaining intelligence to aid their attack planning (Wilbur l. Peart 2010, p14) Planting, especially trees can increase a standoff distance for vulnerable building.	Trees make great cities because a dynamic urban forest supports a healthy community, economy, and environment; Planting is an easy and affordable tool for creating sense of public space and community; Trees create walkable streets, Planting can be an important element in design;	Using trees as an invisible barrier distinguishing pedestrian flows from high speed traffic; Using plantings of creating a desirable plaza for public next to the Railway station building; (Give place back to people) Using plantings for improving ecological situation, and health for Vagzali square communities; Use planting without blocking the views for natural surveillance;

Table 7₅ CPTED, anti-terrorism design, urban and civic design principles optimization for design.

Element	CPTED design goal	Anti-terrorism design goal	Urban planning and civic design goal	Ways of implementing in Tbilisi railway station design
Street furniture	"It must be made of vandal resistant material; It can be used to avoid hidden places close to paths and hidden corners, blind spots or bends that create places that prevent natural surveillance and limit choices" (CPTED, guidelines for Queensland 2007).	It can act like a barrier, prohibiting vehicles from direct penetration to the building.	"It reveals a desire for harmony, heterogeneity and belonging. Street furniture are objects that make the lives of citizen easier and more beautiful" (Blerot, 2013). Street furniture can equip public places like so, to turn them into more desirable places to spend time.	Using street furniture, benches, lightnings and etc. for equipping site in order to create an interesting and desirable security zone, combined with public uses. Increase security level around vulnerable target, in this case, Tbilisi central railway station by designing street furniture, that reveals site character respectively.
Moat	it is traditional environmental design element, that is presented with water features, it can increase the number of activities on the site so as natural surveillance.	Increase standoff distance;	Moats can create an interesting and characteristic element in urban forms. Moat can sometimes act like a barrier, distinguishing places from each other.	Implementing water elements into designing railway station plaza, that on one hand will act like a moat and a barrier for traffic. On another hand, it will improve the quality of recreation that will be offered by newly formed plaza.
Control points	Defines the ownership; Gives information about the place, how long can visitors stay there, what activities are allowed an etc.	Used to screen visitors in order to identify potential aggressors.	People start behaving differently when they are screened and controlled.	Using control points only in most necessary areas, such are railway station car access points and proposed multistory parking building next to railway station.

Table 7₆ CPTED, anti-terrorism design, urban and civic design principles optimization for design.

Element	CPTED design goal	Anti-terrorism design goal	Urban planning and civic design goal	Ways of implementing in Tbilisi railway station design
Plaza	Plazas can be detrimental to CPTED "if poorly maintained and accessed, but if outfitted well can be assets that serve to attract people and increase natural surveillance and better delineate between public and private space." (Rothrock, 2010).	Site surrounded by an open space can turn it into a vulnerable target for terror attacks. However, building requires open space for increased standoff zone. If plazas are equipped with adequate urban and design elements they can be a determinant factor of increasing standoff distance.	Creating plazas in front of buildings can rise the importance of the building itself. (A good example here could be SEAGRAM building in New York, After designing plaza for public realm, building and surrounding territory has become more important for civilian than in was before).	Well-designed plaza next to railway station, considering both urban design and anti-terrorism design principles. Attracting people and at the same time preventing any criminal activities on the site with help of natural and continues surveillance.
Wide sidewalks	Creates more inviting environment for more pedestrian actions; Makes "Eyes on the street" theory more possible;	Increases a standoff distance; Decreases a chance of high speed vehicles direct access to vulnerable targets.	Wide sidewalks enable streets to be designed like so to encourage pedestrian walking; "The importance of pedestrian public spaces cannot be measured, but most other important things in life cannot be measured either...pedestrian places are essential to a city's happiness" (Penalosa 2011).	According to the fact that major core pedestrian roads on thesis site are occupied by traders, design will suggest to turn them into walkable areas by widening sidewalks and suggesting trader's alternative places for selling their products. Equipping sidewalks with security elements for decreasing the chance of vehicle access to pedestrian lane.

3.3.2. Main Conceptual approach and strategies

Considering above mentioned anti-terrorism design, urban/civic design and CPTED principles with the background of thesis research recommendations as well as literature review, a new approach to the site reconstruction has been developed.

First thing that design suggests, is to organize trade. Abolishing illegal outdoor trades from pedestrian underground and over ground passing's. The main intention of this action is to get rid of uncontrolled activities and undesirable flows on the site. Thesis stated that above mentioned activities make site more vulnerable. Alternatively, new organized open-air trade (that will be functioning during weekends and the rest of the week it will serve community as a park and recreational zone) will be designed inside the community on an empty plot (currently used as a temporary parking) (Figure 33). This experimental design decision, is also associated with the research findings that many same functional building redistributions in a surrounding area, turns the site more vulnerable. According to this, new design tries to make shopping destinations in the site more clustered, than it was before, when site was accommodating: Illegal underground, illegal over ground, Community market and shopping malls.

New design also solves parking problems, by creating multi-story parking building next to the central station. Location of parking building will determine its primary purpose, to serve only railway station visitors as well as employees in the building. New parking building will be equipped with devices for continuing surveillance, as well as, entrance and exit barriers (figure 34).

Another new building that will be added on the site is a residential building. It will be constructed in place of old shopping mall "Детский мир", that has been burnt down in 2017. Original building is going to be demolished as far as construction has been damaged significantly that makes it impossible to be repaired (Source: Georgian Union of Architects). Residential building, will be a guarantee of a natural surveillance on railway station and newly created public plaza (figure 34).

In search of increasing natural surveillance, new office building has been designed inside existing abandoned building, originally built for Railway station co-workers. (As far as all offices has been

moved in a new railway station, building has become abandoned) with multifunctional welcoming ground floor offering spaces for co-working environment.

Experimental project also suggests reconstruction of a community market hall in order to regain its popularity. It is an undeniable fact that, after abolishing illegal trade. Site will need an alternative solution.
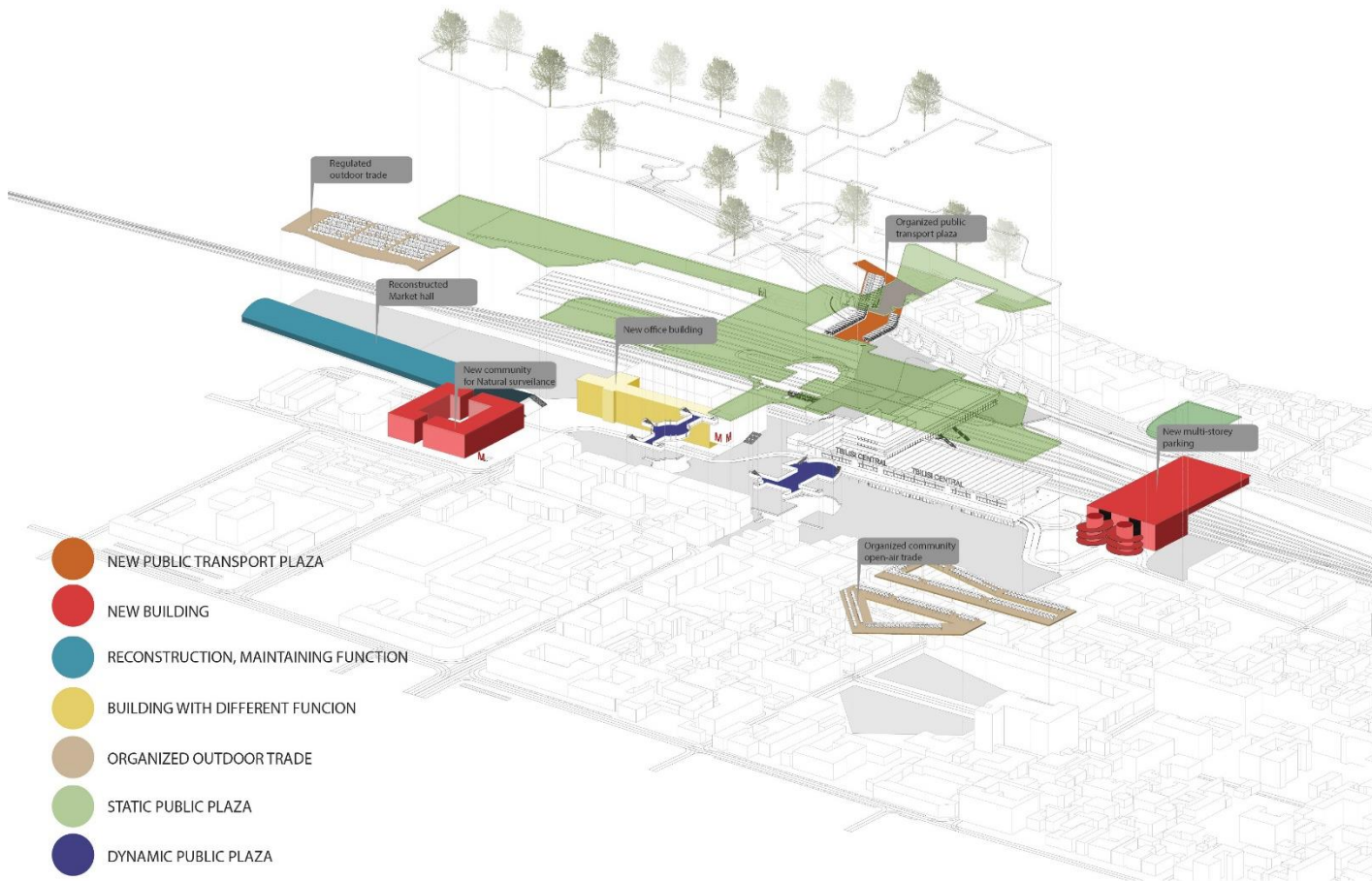
Figure 34 New program for site redevelopment. Illustration prepared by author

Turning into the plaza, that is planned to be organized in front of a railway station building, will be divided into two: Static public plaza, (figure 35) and dynamic public plaza (Figure 36) for organizing special events.

Figure 35 Static public plaza. Illustration prepared by author

Static public plaza is reloaded with recreational spots, children-friendly parks, outdoor community shopping spaces, eating spots and etc. As for plaza behind a central station, accommodates public transport platforms with multiple bus stops as well as a park for commuters (during waiting times). Static plaza, in this case will work as a security zone, at the same time, it will be a desirable space for public realm. In addition to that plaza will extend the distance between vulnerable building and potential threat (in this case vehicles)

Turning into dynamic plaza, that provides various activities to site users, can be considered as the most vulnerable spot in a new design. According to its vulnerability, experimental project suggests controlled exit and entry points, that can be accomplished by existed staircases designed for underground passing's (figure 36).

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Events that plaza could offer for its users, could be following. During spring: Open air museum days, music festivals or other events organized by city government. During summer: plaza can offer free gym days to citizens, the rest of the days it can turn into a rest zone for community. As for Autumn, dynamic plazas can community market in weekends or open-air cinemas. During winter time, here could be organized some events concerts or even ice skating rink. This dynamic characteristic feature of new plazas will ensure its actuality among citizens as well as site visitors.

Entry point   Exit point

Figure 36 Underground passing's as Dynamic public plazas. Illustration prepared by author

3.3.3. Design Process and justification of design solutions

After analyzing site by means of its usability, accessibility (mobility), actuality and etc. Design main goal become to redistribute importance of particular functions to be spread into a larger scale, so as not to make transportation hub a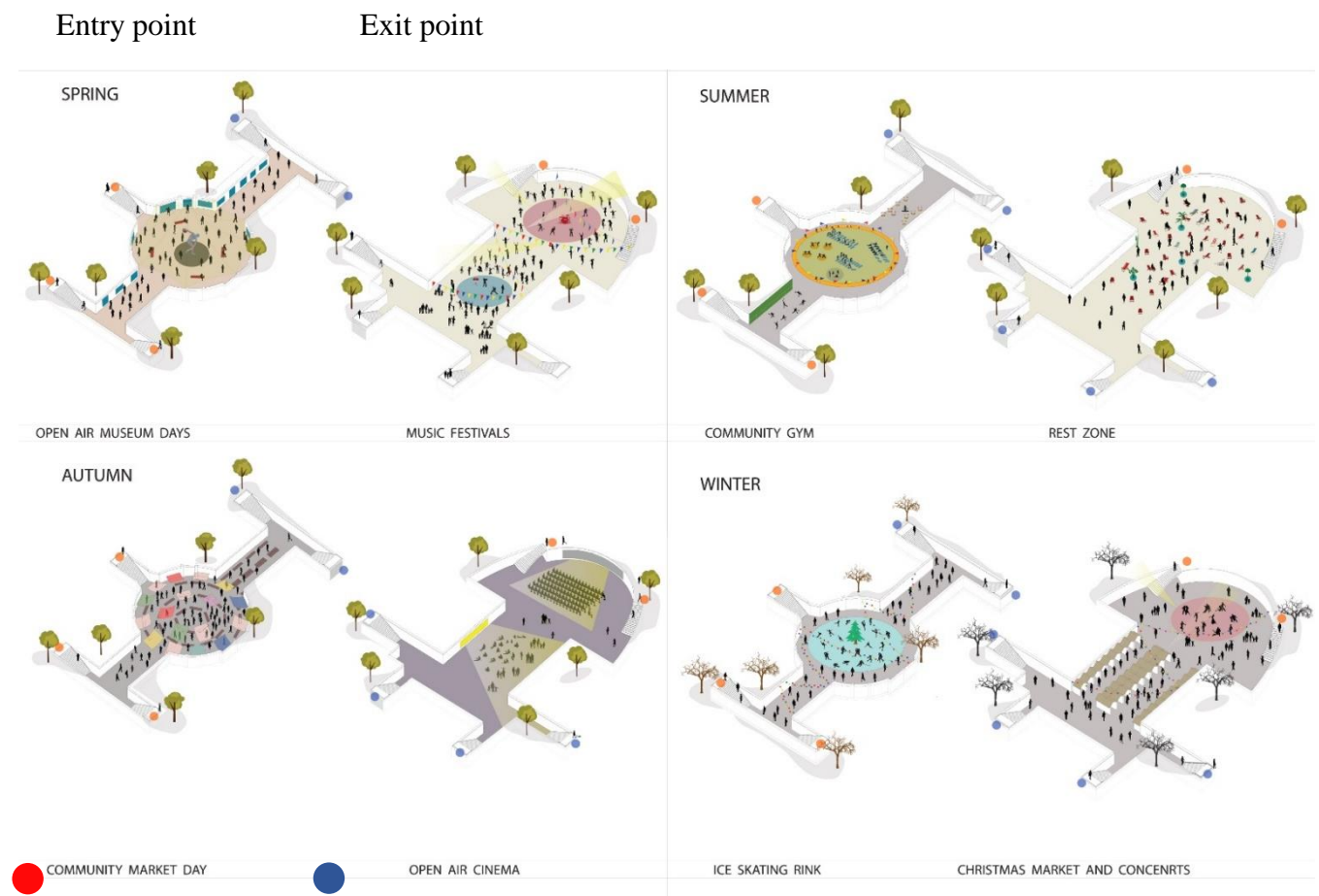 vulnerable target for terror attacks. In search of accomplishing main goal of design with a minimum impact of already planned built environment, various implementations have been done according to conceptual model described in a previous subparagraph.

Starting with a minimal change on a *street infrastructure*. Green lines have been added in almost all major streets, as well as, an appropriate street lighting for better scanning vehicles during late hours. In some places, pedestrian lanes as well as green lanes have become wider and more intense, ensuring natural surveillance on streets (figure 37).

| 30 | 1 | 2.4 | 3.2 | 3.2 | 4 | 3.2 | 3.2 | 2.4 | 1 | 30 |
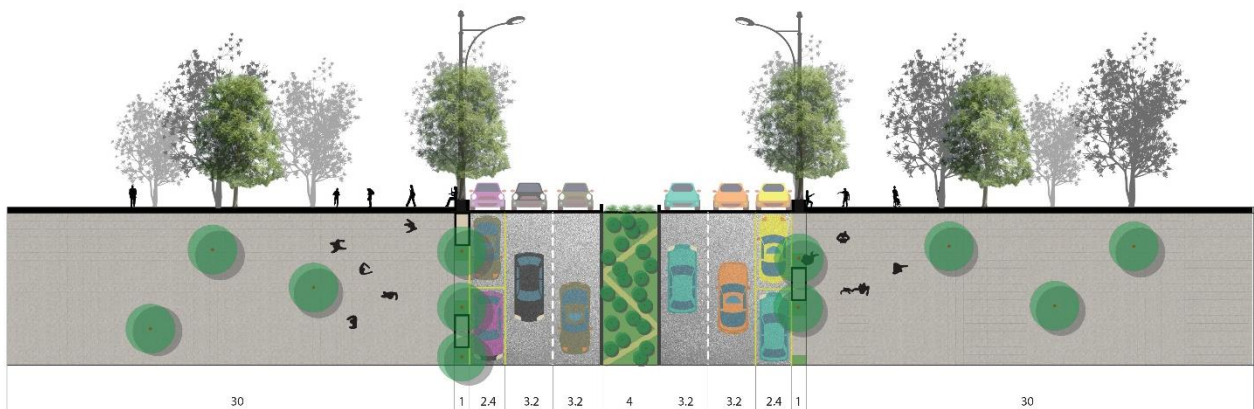
Figure 37 Road section example with extended green line, after abolishing single vehicle line. Illustration prepared by author

In K. Tamar street that can be understood as the major infrastructural core for the site, it was impossible to abolish vehicle lane, however design suggested to diminish vehicle lane width from 3. 8 m to 3.2 meters, resulting continues green lane and slightly wider pedestrian lanes, that on itself is equipped with road barrier elements (Planting pots used as a bollards) (Figure 38)

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As for streets, that have been abolished after considering its importance and the extant of usage by vehicles and pedestrians, has turned into a liner boulevards that serves community demands (recreation and activity plazas). Those roads are separated from active roads with bollard system that can be used as a bench and a planting pots for community purposes (Figure 39).

Figure 38 K. Tamar str. Illustration prepared by author

Vehicles in anti-terrorism design, can be understood as a potential threat, that need to be organized
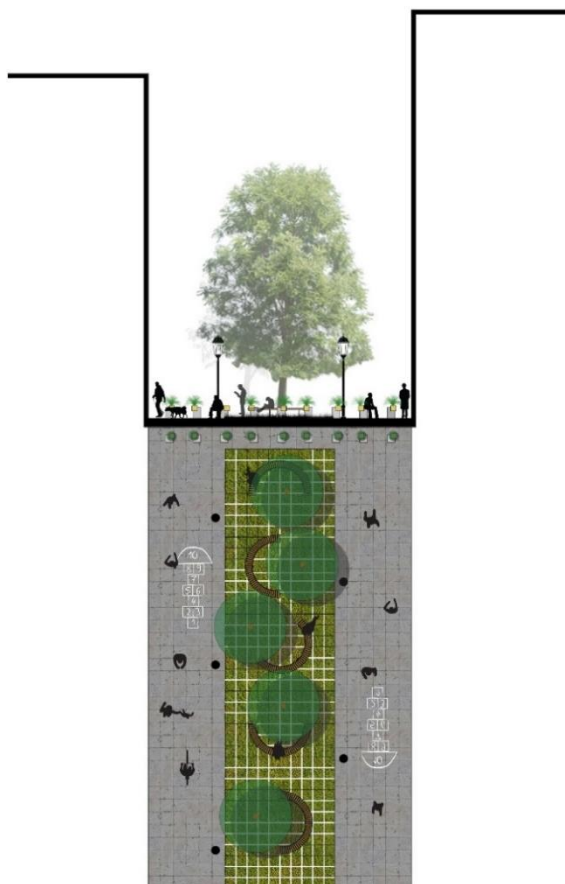
in a special manner. (With controlled barriers, checking points and continues as well as natural surveillance is highly required.)

Problems of parking lot organization in central Railway station territory, has highlighted the necessity of *multistory parking.* It will serve visitors of a railway station, as well as its employees (figure 40). All cars entering and exiting the site will be scanned with CCTV cameras. This will diminish possibility of any potential threats.

Figure 39 Community boulevards instead of vehicle roads. Illustration prepared by author.
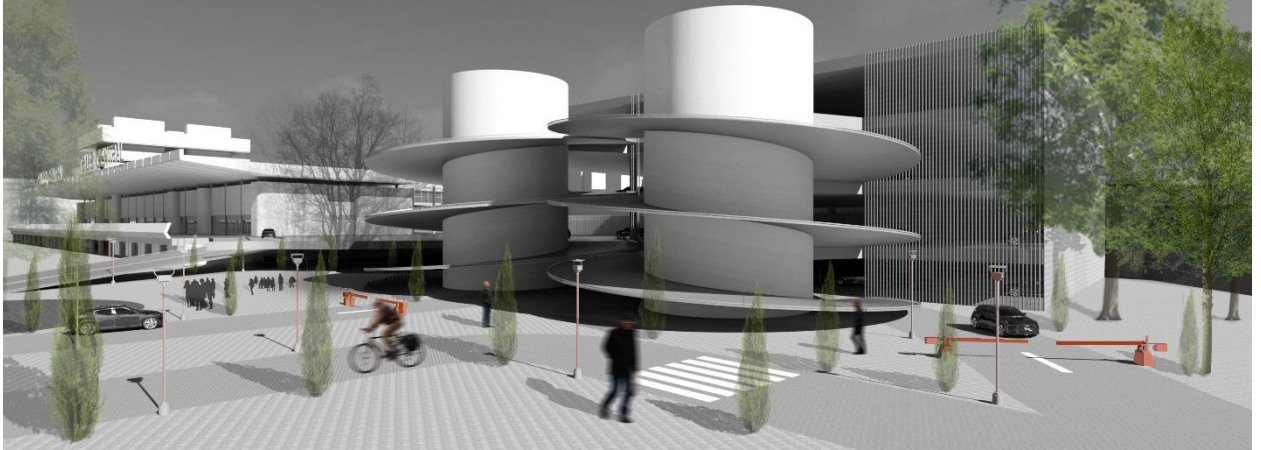
Figure 40 New parking lot next to the railway station.

Turning into a justification of new housing unit's suggestion on the site, the decision was made after a fire accident that caused a complete destruction of original building (shopping mall) (figure 41).

Figure 41 Original building in a Central Station site after fire accident. Photo taken by author in 2017, February

The accident had a significant economic impact on civilians. According to this fact decision was made to devalue important transportation hub and its surrounding site and suggest housing unit instead of another shopping center, with welcoming ground floors. Housing unit location, will enable its residents to keep an eye on railway station plaza as well as their courtyards. (With consideration of CPTED strategies). In addition to this, private entrances and exits to and from the residential complex are strongly defined (figure 42, figure 44).

Same approach has been implemented into an abandoned building, situated next to railway station (figure 43). Experimental design suggests to organize less vulnerable activities on the ground floor.

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Activities include: Supermarket, co-working spaces, beauty salon, gym and etc. (figure 43). Private and public entrances and exits are separated.

The main aim of designing new, less vulnerable objects is to devalue site importance and diminish site visitors number.

PUBLIC

PRIVATE

ENTRANCE FOR RESIDENTS

PUBLIC ENTRANCE

CAR ENTRANCE

Figure 42 Housing complex ground floor plan

Figure 43 Office building ground floor plan

Figure 44 New housing units, reconstructed office building and surrounding site reinforcement. Illustration prepared by author

In order to redistribute importance of the site, some shopping destinations has been spread into residential zones. Design suggests a weekend *community outdoor trade* while in other days' area will be used as a park for inhabitants (figure 45). Experimental design intends, that a temporary activity on the site will make the territory easier to be controlled with both natural as well as continues surveillance. In addition to that new outdoor trade will bring people from railway station to districts. This circumstance will lead to realization of research project 2 strategy:

'…Redistribution of importance of buildings'.

Another aspect that design considers is using existing layout of trade. More precisely reverting importance of community market. Illegal trades on the site was acting like a barrier serving customers directly in front of metro entrances and public transport stations. Consequently, *legal community market* building was not used adequately. However, after banning shopping on the streets design intends that market building will have more visitors. According to this design comprised reconstruction procedure of old building and turn it into more desirable shopping venue than it was before.

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Figure 45 Community outdoor market. Illustration prepared by author

Radical changes have been done in organizing plazas around station building. Design uses plaza for ensuring security zone of potential terrorist target object. As has been mentioned in a previous paragraph plaza suggests various activities to its users. In addition to that plaza is organized like so that it provides a clear vehicular entry and exit points to and from the site, that on itself has been diminished in number and now it is presented with 2 entry points and 2 exit points from where 1 entry and 1 exit point serves only public transport cars. (figure 46) Design elements: mound, trees and plantings, Bollards, stairs and ramps are used as a protection elements for the station building.
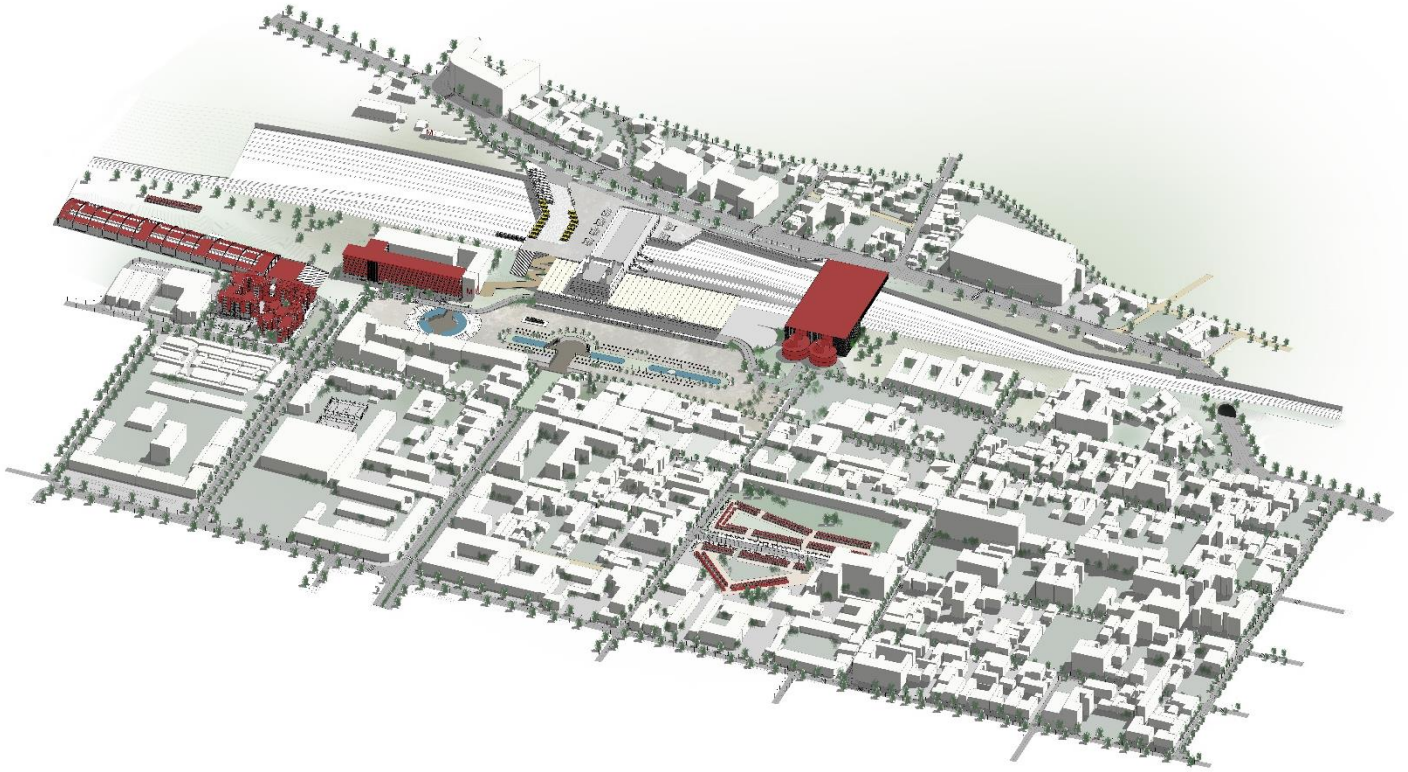
Figure 46 Overall expression of experimental design implementation. Illustration prepared by author

3.3.4. Suggestion for surrounding land use development and changes in zoning plane

In the end of experimental design project of *urban planning and design for terrorism resilient cities*, it is relevant to compare existing land use to a proposed land use plan and predict the development strategies of an area, surrounds vulnerable transportation hub. As it is illustrated by figure 46 considering security design principles does not have a dramatic impact of site's

Existing land use   Proposed land use

Explication

High intensity commercial/ mixed use zone;	Railway station;
Medium intensity commercial;	
High density residenti zone;	
Low density residenti zone;	
Light industrial zone;	
General public open space zone;	
Transportation zone 1;	
Transportation zone 2;	
Site boundaries;	

Figure 47 Existing and proposed land uses comparison for experimental design site. Illustration prepared by author

current situation (figure 47). Although, new public plaza is turning medium intensity commercial zone into general public open space. Transportation zone has been diminished after design proposal of new office building, instead of old railway station office building. In addition

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to this, community market reconstruction, caused to turn existing zone into a high intensity commercial mixed use zone (previously, zone was included into transportation zone as the building was originally built as a Borjomi railway station). However, multistory parking building has turned low density residential zone into transportation zone, presented with general public open space.

As for some streets that were closed for vehicles, conferred to general public open space. Organizing platform for public transport users behind railway station building, has clearly outlined generic public open space zone as well.

CONCLUSIONS

Main objectives and tasks of experimental design was to test urban forms, elements and other recommendations, in order to rise security level at Tbilisi central railway station site. In addition to that, experimental design considers existing, already planned community context and historical urban layout. It is strongly believed that, while designing new, existing should be maintained and preserved. However, during design process, it has been outlined that "there is no one-size-fits-all rule that will provide a high level of security for every project site" (Droge and Hopper, 2005). Even though, there is no 'one size fit solution' for all sites, findings of anti-terrorism design principles and implementation in real problematic urban environment, gave general recommendations on how to rise security level, while protecting and maintaining the image and distinctive character of the area

- For elements of site reorganization, design suggested minimalizing vehicular accesses to and from the site by two different ways. Firstly, abolishing some roads by disconnection secondary roads from major streets. Design intends that it will lead to less integrated, so as less vulnerable roads and places respectively. Although, it was impossible to make radical changes in Tbilisi infrastructural network, while working on a small site and not on a whole city. For future design projects, experimental design recommends considering the whole cities transportation network and change road system with larger scale implementations. Abolishing some roads, will turn railway station building relatively hard to be accessed by vehicle, especially without going through the checking points or without scanning by CCTV cameras. New multi-story parking building will ensure regulating chaos, caused by private cars. New residential building as an addition of a site composition, will ensure safe activities in the perimeter, as well as make Jacobs 'eyes on the street' theory possible.

- As an initially conclusion can be said that, site analysis has highlighted complexity of Tbilisi central station and its surrounding territory, by means of public transport diversity presented on both sides of Railway tracks, as well as different kinds of zones redistributed on the site (residential, commercial, transportation and industrial zones and etc.). In this chapter necessity of public open space has been highlighted (small territory of greenery not sufficient for community purposes, as well as for site visitors). Irregulated parking lots, easy vehicular access to and from the site, turning it into less terrorism resistant place. Same can be said about multiple legal or illegal shopping destinations, causing higher concentration of users in particular spots. Even though site has a lot of

users, there is still a lack of urban life. Site function is only oriented on transportation and trade, whereas in fact no entertainment is offered for people who are actually living there.

- Turning into strategies and conceptual approaches, formed after analysing the site and considering environmental elements, highlighted in a chapter 2. Experimental model, tried to redistribute values of the place and spread it farther from a station building.

    For instance, design suggests alternative weekend community trade in the heart of residential district. This will therefore 'devalue' central railway station and its surrounding territory and will inevitable transfer concentration of people inside districts. In addition to that, abolishing illegal trade and giving back the importance of original community market building, will regulate ways of using site adequately and in a right manner.

    Site analyses has also outlined the issue of irregulated parking lots on the site, that hard to be controlled either by natural or continues surveillance. Solution, that experimental design suggests, is a new multistory parking for railway station visitors and its employees. This approach, can be understood as an alternative way of how to increase security in vulnerable major buildings, by isolating them from high risk urban areas. In this case, experimental design proposes a partly isolating parking from railway station and putting it into highly controlled multi-story parking building.

    As for public transport, design solves the problem of disorderly distributed various means of public transportation, by concentrating them on one spot. This will lead to clearly defined space for mini buses and public buses. Controlling exit and entry points for public transport, will ensure safety of passengers as well as site users.

    Apart from increasing standoff distance of central station, plaza has a strong social value. Dynamic public plazas offering various sessional community activates, that on itself will bring the community together. As for static public plaza with recreations, cafes and rest areas will act similarly as dynamic public plaza.

- There were number of environmental design solutions and recommendations for anti-terrorism design, formed by empirical research. Solutions, have been used to be implemented in experimental design. For instance:

    'Redistribution of same functional buildings in a small territory, will lead to terror attack' recommendation, implemented into redistribution of trade. Resulting reloading district importance and devaluing particular areas.

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'Minimalizing vehicle access point to the building.' While transforming transportation zone into recreational zone, lot of streets, that has a direct access to railway station building, automatically abolished. Remaining only 2 Entry and 2 exit points that are strongly defined and controlled. 'Site has a direct access to the main street will lead to terror attack', even though K. Tamar street was disconnected from plaza, this strategy has not fully accomplished by experimental design. As for, disconnected railway plaza from C. Dadianis street that is the most integrated road on the site was impossible.

'Separating public and private activities' in experimental design public activities, in this case residential courtyards and apartment buildings are functioning separately, isolated from public spaces with gates, bushes and etc.

'Well used site', experimental projects suggest territory to be well used, by creating multifunctional plazas. Regulated functions on site, will therefore guarantees correct usage of spaces by civilians.

'Direct access to the city center', as has been decided in the beginning of formatting conceptual model, this environmental feature is hard to be achieved in already planned road network. However, after abolishing few streets on the site, city center has turned into slightly less accessible place from Central station site.

- Experimental design used Jacobs 'eye on the street' theory. According to this theory, for increasing natural surveillance on plaza, new residential apartment building has been proposed on an empty plot. Experimental design also suggested reconstruction of existing office building for increasing natural surveillance on the site. All above mentioned strategies, has been implemented in a problematic area of Tbilisi, rising security level on the site with appropriate design elements, invisible to public eyes.

It is relevant to mention *experimental design process weaknesses.* As has been mentioned before, different sites need different approaches. Design process has shown that some research aspects are unsuitable for particular cases. In addition to that, it is almost impossible to predict, weather proposed design will work in that particular cases or not. Another drawback of experimental design could be chosen site complexity and functional diversity, proposed by the area that arises other problems as well.

WHOLE WORK CONCLUSIONS

1) Starting with defining most vulnerable target objects for terror attacks. Despite the fact that, at first glance terrorist organization randomly select sites and objects for fulfilling their political or religious ambitious, in reality, thesis work showed that target object selection is a tactic process, carried out by terrorist organizations, comprises foreseeing in advance success rate of an attack, determined by a particular area, a possible number of causalities, as well as, the possibility to access selected territory without any complications. In accordance with literature review, architectural objects and urban sites can be classified as 'hard' and 'soft' targets. Generally, terrorists avoid attacking 'hard' targets such are: governmental buildings, nuclear power plants, foreign embassies, military headquarters and etc. As for 'soft' targets, historically major cities were attractive venues for terrorists and aggressors, nowadays crowded, public places have turned unsecured. Although, this thesis case studies have outlined, that terrorists avoid 'hard' targets, is only a widely accepted stereotype. However, in reality, any major places, that could be foreseen as a well-used site (with political, religious, cultural, touristic and etc. values), can be expected as a potential and an attractive venue for terror attacks.

2) Turning into Empirical research, for identifying environmental design features, that turned out to have a momentous importance for anti-terrorism design studies. It has been proved by thesis, that uncontrolled entry and exit points to and from the site will ensure its reinforcement. According to the fact that vehicle is understood as a potential threat, it appeared that diminishing vehicular access to the building will decrease its vulnerability rate as well. Even though, planners aim is to create spaces that will be used by civilians, thesis pointed out that well-used sites can turn into attractive target for terrorists. The chance of terror attacks is relatively high, when private activities are strongly separated from public activities. Even though FEMA guidelines suggest redistribution same functional vulnerable buildings together in order to increase standoff distance, research findings clarified Augurs idea of dispersing major infrastructural cores in the city (Augur, 1948). It turned out that, there is a medium chance of attack if same functional buildings are redistributed in a surrounding area. In addition to this, it is important to clearly define accesses to private and public spaces. Research also proved that site, with direct access to the main street, as well as to the city center, can be turned into attractive target for terrorists. The importance of standoff distance has also been outlined by research. Furthermore, presence of medical institutions on the site as well as security forces may elude possible attack. According to prognoses, the chance of attack in this case is relatively low.

3) As for investigating spatial urban structure, thesis conclude that streets with high global integration values are more likely turning into venues for terror attacks. Accordingly, in order to transcend vulnerability, it is important to organize road network in a complex way, in search of decreasing chances of an easy access to potential target objects of the city. This finding could be associated with planning strategies for medieval towns, irregular planning and dispersing facilities to confuse enemies (Gutjahr,1999).

4) Thesis initial suggestion on cooperation between anti-terrorism, CPTED, civic and urban design principles have concluded that anti-terrorism design findings can be humanized. To give an illustration on refining

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holistic anti-terrorism architecture, we can start with the idea that entry and exit ways can be limited by disconnecting some vehicular secondary streets from vulnerable targets. Instead of minimalizing vehicular access points to the building, thesis proposes to use London 'ring of the steel' strategy and control all exit and entry ways with CCTV cameras, as well as with natural surveillance (residents, site users and in some case police force). Even though well-used sites are attractive targets for terrorists, considering placemaking principles, thesis proposes to regulate interesting activities on station plazas, instead of abolishing them (prohibiting temporary parking, illegal trade and etc.) and create interesting spots in a surrounding territory, using space accordingly, by loading with various safe activities is a key principle of 1st generation CPTED as well. With regards to separation between public and private activities, thesis suggest creating semi-private transitional zones that will be foreseen for specific groups as well as for site users. In order to humanize principle of avoiding redistribution same functional buildings in the surrounding area, thesis suggests to disperse the importance of existing program on the site (by moving outdoor trades far away from a station building). As for humanizing principle of clear definition of access to private and public spaces, thesis has no specific suggestion as far as entrances to private properties (residential houses) on proposed site are already protected with fences or gates. According to the fact that direct access to the city center and to the main street increases site's importance and chances of an attack, for refining strategy, design suggested isolated site plaza from major street (K.Tamar street). However, in most cases this strategy is impossible to be fulfilled. Turning into site location on globally integrated street practice, thesis work highlights the importance of closing some secondary streets for vehicular flow, consequently, disconnected from major roads that will therefore decrease its global integration value and at the same time will assists the idea of 'invisible' security.

5) From the outcome of experimental design investigation, it is possible to conclude that the main concern of hiding security planning strategies behind aesthetically pleasant or 'invisible 'design elements is feasible to be achieved to some extent. According to experimental design, Tbilisi central railway station site has been foreseen as potential terrorist targets. Identifying district working mechanism, its characteristics and basic functions that inevitable need to be maintained, led to minimal implementations in already built environment. It is a significant fact to be mentioned that area required strong functional reclassification, for security design interventions, organize safe activities in unsafe locations and unsafe activities in safe locations. Design has not damaged its distinctive characteristics, moreover it emphasized site basic functions: transportation, shopping, living and leisure (however, in a more organized way). Plazas surrounding station building, have 2 ideological and functional loads. From placemaking point of view, it tried to meet site permanent and temporary users demands by offering various activities inside a strongly defined borders. As for anti-terrorism design strategies, it extends distance between vulnerable object and vehicles (2nd layer of defense) and gives opportunity to reinforce territory by various 'invisible' anti-terrorism elements, disposed around station building (trees, planters, bollards, street furniture and etc.). As for new residential building and office building, except its basic function, its users will ensure natural surveillance on vulnerable territory.

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Consequently, it will be associated with social context that had been outlined by civic design principles as well as 2nd Generation of CPTED.

To be short, anti-terrorism 'four Ds' strategy have been accomplished in a following way (Table 6)

Deter	Detect	Deny	Devalue
Creating plaza for increasing stand-off distance, reinforcing territory with mound, trees, Bushes and etc.	CCTV cameras, natural surveillance provided by residents and workers form office building.	N/A	Redistributing site functions in safer zones: relocating outdoor trade in a residential zone

Table 6 Organized design solutions by means of anti-terrorism design 'four Ds' strategy

Ana Petriashvili. 'Urban Planning and Design for Terrorism Resilient Cities'. *Master's* Final Project supervisor assoc. prof. dr. Irina Matijosaitiene; Faculty of Civil Engineering and Architecture, Kaunas University of Technology.

SUMMARY

Thesis was composed of three chapters, each chapter used different methodology and tools for addressing the issue of urban planning and design for terrorism resilient cities. Literature review, field research and experimental design had proceeded to answer thesis main questions.

literature review focused on four environmental design principles: anti-terrorism design, CPTED, urban and civic design. Anti-terrorism design had highlighted four main strategies ('four Ds'): deter, detect, deny and devalue. For humanizing holistic anti-terrorism design architectural and urban principles, thesis also considered rest three design strategies. In the end of the chapter a hypothetical model had been built. Accordingly, thesis work was able to go forward.

Two completely independent field researches had carried out in order to test thesis hypothesis and answer its main question. First part of a research, identified environmental design factors that influence choice of places for terror attacks, as for second part, it identified spatial urban structure that influenced choosing specific areas for an attack while avoiding others. For accomplishing first part of a research, 'Yes/No' questioner had developed based on CPTED checklist and FEMA guidelines for anti-terrorism design strategies, as well as considered hypothetical model principles. Google earth streets views for 14 sites with recent terror attacks and 21 sites without terror attacks have been assessed with 'Yes/No 'questioner. Later on, correlation and liner regression analyses had processed, leading to discovery of 9 major environmental elements that had a strong correlation with terror attacks, finishing with descriptive statistics, that outlines 12 major environmental elements. As for second part of a research, it carried out for investigation spatial urban structures by syntactical analyses of 6 sites (analysing major space attributes: connectivity, mean depth, integration and choice values), affected by terror attacks.

The final stage for composing a thesis work was testing findings reasonableness by implementing strategies developed by previous researches into real problematic urban area. Initially, a vulnerable

target object had been selected with space syntax method. Considering sites complexity, a conceptual model had been built, adjusted to site characteristics. Apart from dealing with site vulnerability problems, for 'hiding' hostile anti-terrorism design elements behind aesthetically pleasant design, other issues, such are: mobility, urban life, shopping, living and etc. had also taken into account.

Thesis finished with main work conclusions answering thesis main tasks.

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Variable 8 and Variable 40

ANOVA Table[a]

			Sum of Squares	df	Mean Square	F	Sig.
VAR00040 * VAR00008	Between Groups	(Combined)	1,313	1	1,313	6,000	,021
	Within Groups		5,688	26	,219		
	Total		7,000	27			

a. With fewer than three groups, linearity measures for VAR00040 * VAR00008 cannot be computed.

Measures of Association

	Eta	Eta Squared
VAR00040 * VAR00008	,433	,188

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	5,250[a]	1	,022		
Continuity Correction[b]	3,646	1	,056		
Likelihood Ratio	5,445	1	,020		
Fisher's Exact Test				,054	,027
Linear-by-Linear Association	5,063	1	,024		
N of Valid Cases	28				

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 6.00.

b. Computed only for a 2x2 table

Variable 28 and Variable 40

ANOVA Table[a]

		Sum of Squares	df	Mean Square	F	Sig.
VAR00040 * VAR00028	Between Groups (Combined)	1,522	1	1,522	7,222	,012
	Within Groups	5,478	26	,211		
	Total	7,000	27			

a. With fewer than three groups, linearity measures for VAR00040 * VAR00028 cannot be computed.

Measures of Association

	Eta	Eta Squared
VAR00040 * VAR00028	,466	,217

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	6,087[a]	1	,014		
Continuity Correction[b]	3,896	1	,048		
Likelihood Ratio	8,027	1	,005		
Fisher's Exact Test				,041	,020
Linear-by-Linear Association	5,870	1	,015		
N of Valid Cases	28				

a. 2 cells (50.0%) have expected count less than 5. The minimum expected count is 2.50.

b. Computed only for a 2x2 table

Variable 30 and Variable 40

ANOVA Table[a]

		Sum of Squares	df	Mean Square	F	Sig.
VAR00040 * VAR00030	Between Groups (Combined)	1,023	1	1,023	4,452	,045
	Within Groups	5,977	26	,230		
	Total	7,000	27			

a. With fewer than three groups, linearity measures for VAR00040 * VAR00030 cannot be computed.

Measures of Association

	Eta	Eta Squared
VAR00040 * VAR00030	,382	,146

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	4,094[a]	1	,043		
Continuity Correction[b]	2,620	1	,106		
Likelihood Ratio	4,273	1	,039		
Fisher's Exact Test				,103	,052
Linear-by-Linear Association	3,947	1	,047		
N of Valid Cases	28				

a. 2 cells (50.0%) have expected count less than 5. The minimum expected count is 4.50.

b. Computed only for a 2x2 table

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Variable 32 and Variable 40

ANOVA Table[a]

			Sum of Squares	df	Mean Square	F	Sig.
VAR00040 * VAR00034	Between Groups	(Combined)	1,522	1	1,522	7,222	,012
	Within Groups		5,478	26	,211		
	Total		7,000	27			

a. With fewer than three groups, linearity measures for VAR00040 * VAR00034 cannot be computed.

Measures of Association

	Eta	Eta Squared
VAR00040 * VAR00034	,466	,217

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	6.300	1	,012		
Continuity Correction[b]	4,375	1	,036		
Likelihood Ratio	6890	1	,009		
Fisher's Exact Test				,033	,016
Linear-by-Linear Association	6.075	1	,014		
N of Valid Cases	28				

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Variable 34 and Variable 40

ANOVA Table[a]

			Sum of Squares	df	Mean Square	F	Sig.
VAR00040 * VAR00034	Between Groups	(Combined)	1,522	1	1,522	7,222	,012
	Within Groups		5,478	26	,211		
	Total		7,000	27			

a. With fewer than three groups, linearity measures for VAR00040 * VAR00034 cannot be computed.

Measures of Association

	Eta	Eta Squared
VAR00040 * VAR00034	,466	,217

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	6.087	1	,014		
Continuity Correction[b]	3,896	1	,036		
Likelihood Ratio	8,027	1	,009		
Fisher's Exact Test				,041	,020
Linear-by-Linear Association	5,870	1	,015		
N of Valid Cases	28				

Variable 36 and Variable 40

ANOVA Table[a]

			Sum of Squares	df	Mean Square	F	Sig.
VAR00040 * VAR00036	Between Groups	(Combined)	1,834	1	1,834	9,232	,005
	Within Groups		5,166	26	,199		
	Total		7,000	27			

a. With fewer than three groups, linearity measures for VAR00040 * VAR00036 cannot be computed.

Measures of Association

	Eta	Eta Squared
VAR00040 * VAR00036	,512	,262

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	7,337[a]	1	,007		
Continuity Correction[b]	5,390	1	,020		
Likelihood Ratio	7,788	1	,005		
Fisher's Exact Test				,018	,009
Linear-by-Linear Association	7,075	1	,008		
N of Valid Cases	28				

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 5.50.

b. Computed only for a 2x2 table

Predictor Importance

Target: VAR00040

VAR00033

VAR00030

VAR00036

VAR00008

0,0   0,2   0,4   0,6   0,8   1,0

VAR00008   VAR00033

Least Important   Most Important
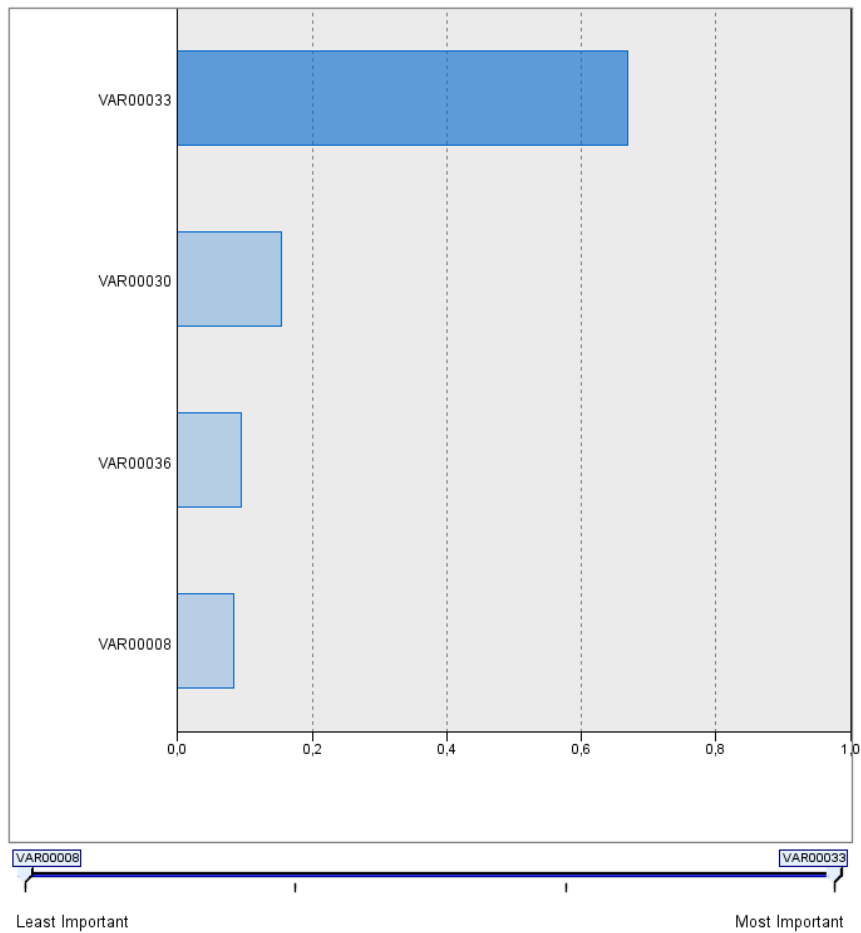
Model Summary

Target	VAR00040
Automatic Data Preparation	On
Model Selection Method	Forward Stepwise
Information Criterion	-68,616

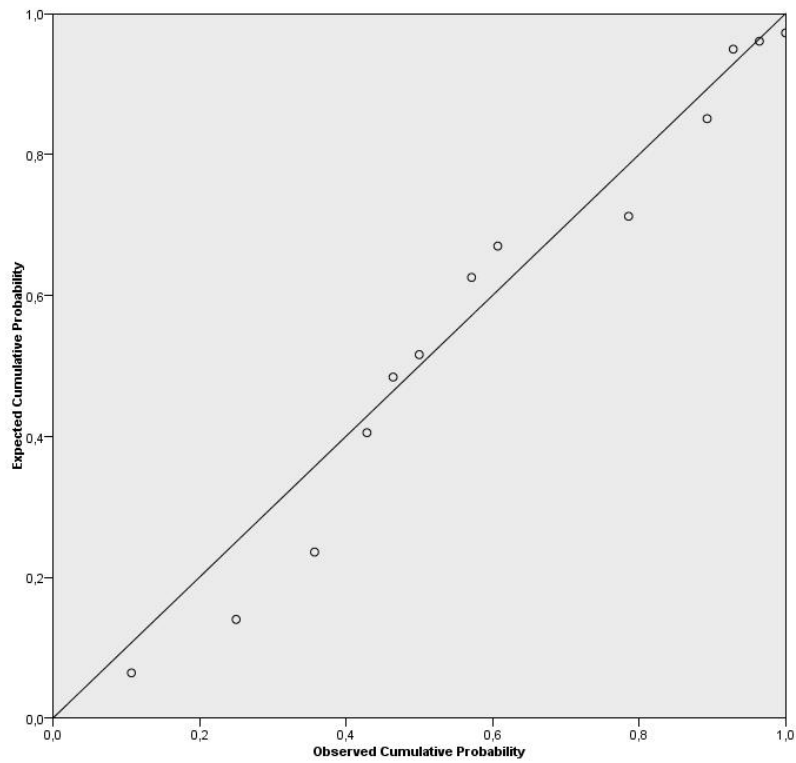The information criterion is used to compare to models. Models with smaller information criterion values fit better.

Worse   Better

Predicted by Observed
Target: VAR00040
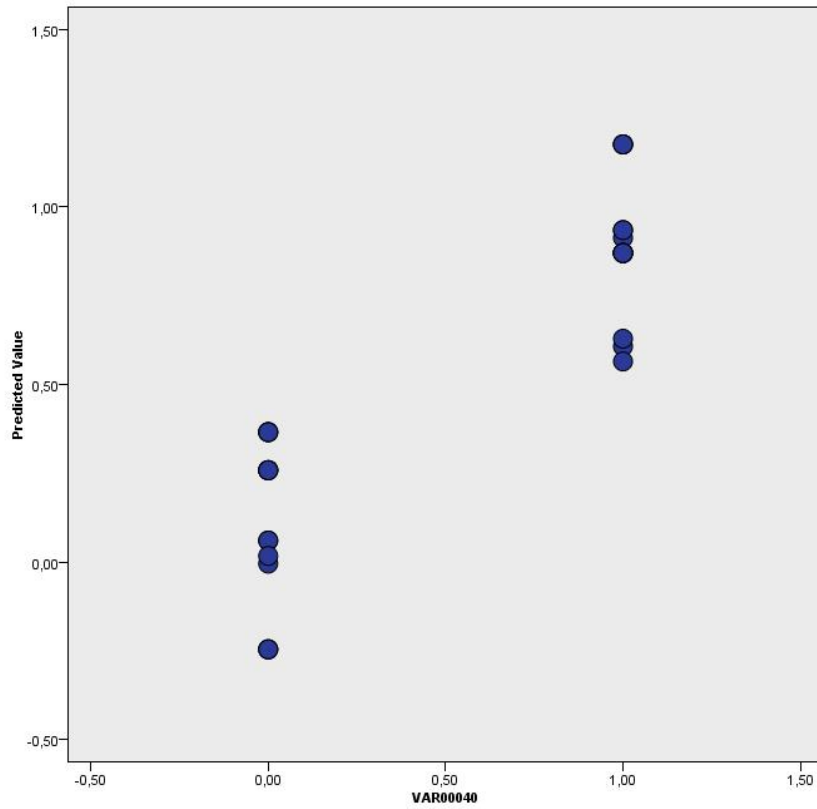
Residuals

Target: VAR00040

The P-P plot of Studentized residuals compares the distribution of the residuals to a normal distribution. The diagonal line represents the normal distribution. The closer the observed cumulative probabilities of the residuals are to this line, the closer the distribution of the residuals is to the normal distribution.