

Assessing Impacts of Passive Defense Policies Interventions on Spatial Logic of Tehran Metropolitan Area (TMA)

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1 ABSTRACT

Security and reduction of vulnerability of the city, as a place of conflict, disorder and terrorism have been considered by various countries since the past up to now. In this regard, the militarization of urban spaces is not always an effective option in establishing security firstly because of high costs of security establishment and then revelation of the strategic spaces. Nowadays, planners have started to think more creatively about how they can hide security behind planning and design features.

With emphasis on passive defense concept all around the world, defining new spatial logics and including related policies in urban spatial development plans have been cited in planning agenda. The importance of Tehran metropolitan area, as political and economic capital due to accumulation of power, population, activities and wealth, has made application of passive defense policies necessary. So the goal of this research is to assess impact of interventions resulting from application of principles and policies of passive defense on Tehran metropolis spatial logic and to formulate appropriate framework of spatial development policy making for vulnerability reduction.

2 PREFACE

In the present preface, necessity for dealing with research issue is elaborated and history of research in the world and Iran is explained and goal and method of research are mentioned in order to achieve the goal.

2.1 Elaborating Role of Urban Spatial Structure of City in Reduction of Vulnerability and Increase of Security

Subject of security and reduction of vulnerability of city (as place of conflict, crime, disorder and terrorism) and continuation of development in different military and nonmilitary methods have been considered by different countries in the world since the past. In this regard, militarization of urban spaces is not regarded as a suitable option for establishing security due to necessity for establishing balance between costs and benefits of security and revelation of strategic spaces. This subject led the planners to think about other unobservable methods of security establishment in covering features of planning and design. Unobservable methods make cities more beautiful and convert them to more pleasant places for spending leisure time while realizing goal of establishing security (Briggs, 2005). In this regard, importance of passive defense is regarded as the third layer of response to threat.

2.2 Elaborating History of Passive Defense Principles Application

Idea of passive defense is regarded as important element in thought of strategic planning of America and other threatened countries (Pedatzur, 2007). Passive defense is defined as set of actions which and seek to limit damages resulting from war, improve capabilities of space in order to protect life of the citizens and minimize life losses resulting from war without any need for application of military equipments and firearms and only based on planning of urban spatial structure from two perspectives of form and function (Lacina, 2006). Goal of application of passive defense is to increase continuation of vital operations and activities and to give service to vital, critical and important centers at time of threat and crisis. Now, the planners have found that the built environments and form of the city play important role in increase of urban security (Liesette, Frances & William, 2001). Elaboration of this relation has led the researchers and professionals of different disciplines to search for suitable forms of urban places of residence for establishing sustainability and urban security (Jabareen,?). This effort can be manifested in emergence of defensible Space (DS) theory¹ as well as effort to study role of counter-terrorism policies in internal form and structure of metropolises in order to achieve more sustainable urban form especially after event of 11 September

¹ Defensible Space (DS) theory of Oscar Newman –urban architect and planner –includes thoughts about prevention of crime and establishment of security in urban districts which was extended in early 1970s and a book was written about it in 1972.

(Marcuse, 2002) not only in New York but also in most developed countries in the world. In Iran, passive defense principles have been considered in design of spatial structure of cities since the past up to now. Spatial structure of material city including a central powerful core with impenetrable strengths, construction of Persian city affected by defensive strategies of Achaemenid Empire in strategic and border points, circular structure of Parthian cities for establishing enough security in Parthian lands which are subject to internal and external insurrections, attention of the Sassanid to selection of a place for establishing city using factors or natural barrier for making access to city difficult, defensive elements of city in Islamic periods including castle, bulwark, and trench, centrality of Feudal castles and fortifications in Safavid period all are indicative of importance of defense in Ira since the past up to now (Mir Ahmadi and Yadegar Zendehe, 2011).

2.3 Explaining Goal and Method of Research

Governing conditions of global society, hostility of the western autocratic states and USA and Israeli against Iran as well as special position of the land in critical zone of Persian Gulf and Middle East made defensive preparedness necessary in all fields. In modern wars, goal of the enemy is to remove strategic centers and activities not people and in gravity center destruction strategy which is known as Five Strategic Rings of Warden,² the attacked country is regarded as an organic system and the most important duty in war planning is to identify gravity center of the attacked countries (Movahedi Nia, 2007). Centralization of five strategic rings in Tehran as the political and economic capital of Iran necessitates importance of this metropolitan area due to accumulation of power, population, activity and evident wealth and application of passive defense policies for reducing vulnerability. In this regard, goal of the present research is to evaluate effect of policies and principles execution interventions on spatial logic of Tehran metropolis and formulate suitable spatial development policy making framework in order to reduce its vulnerability. In order to achieve the mentioned goal, the selected process and method applied in each stage include the following steps:

- Elaborating passive defense principles and criteria by archival study and history of this field
 - Identifying and understanding effects of application of passive defense principles and criteria on urban spatial structure generally /deducing spatial representation of principles and criteria of passive defense.
 - Recognizing the status quo of Tehran metropolis based on circumstances of passive defense
- Measuring vulnerability of spatial structure of Tehran metropolis by adapting elements of urban spatial structure to spatial representation of passive defense principles and criteria
- Formulating suitable spatial development policy making framework and presenting vulnerability reduction strategies.

3 IDENTIFYING AND UNDERSTANDING EFFECTS OF PASSIVE DEFENSE PRINCIPLES AND CRITERIA APPLICATION ON URBAN SPATIAL STRUCTURE GENERALLY/ DEDUCING SPATIAL REPRESENTATION OF PRINCIPLES AND CRITERIA OF PASSIVE DEFENSE

It was mentioned before than urban spatial structure plays important role in reduction of vulnerability and increase of security and sustainability of the city against potential attacks. One of the key branches which plays major role in completion of passive defense goals is use of spatial development planning (Maleki and Brandkam, 2011). In this regard, different countries have included new spatial logics in agencies of urban spatial development agendas in order to achieve security and sustainability based on subjects of passive

² In theory of Five Strategic Rings of Warden which was mentioned by an American retired colonel in 1988, gravity centers of a country were regarded as organs of a body which will be crippled in case of destruction of each part of the country and will not be able to continue working. These gravity centers can be classified as five strategic rings : the first ring –national leadership includes political leadership, main centers of political and military decision making (ministries, command post , telecommunication , Broadcasting Organization) as brain and neural system of the country , the second ring –key precuts including power plants , raw material production heavy industries and centers, military equipment production industries , water supply network etc as digestion and blood flow system , the third ring as communication infrastructures including airports , railway , roads and bridges as motor organs , the fourth ring –the public and the fifth ring –operational forces as defensive cells.

defense. Determination of special spatial logic in Iran resulting from execution of passive defense policies requires the following steps:

- Identifying passive defense principles and criteria.
- Explaining elements of urban spatial structure.
- deducing representation of passive defense principles and criteria in elements of urban spatial structure.

3.1 Identifying passive defense principles and criteria

Achieving goal of sustainability and reducing vulnerability of city from the viewpoint of passive defense subjects first require identification of passive defense principles and criteria which are related to urban spatial structure.³ These principles are studied in some general classes including camouflage, concealment & cover, deception, separation, dispersion, multi-functionality of urban elements and access (Movahedi Nia, 2007).

Principle of camouflage

The main factors which facilitate identification of a strategic goal include form, shadow, texture & shine. Therefore, making texture and form of installations, equipments and forces equal to the surrounding environment makes identification difficult (Movahedi Nia, 2007). Concealment means utilization of equipments and methods for concealing, homogenizing, transforming and simulating, creating deceptive goals and deleting regular geometrical shape in order to prevent the detectors and sensors of enemy from discovering and identifying forces, equipments, installations and activities (Maleki and Zarifi, 2011). Methods of concealment are different in lifestyle of the system (Ghanbari, 2011) and (Movahedi Nia, 2005 and 2007):

- Surface treatments which are applied for design of new systems and along with them are a part of the performed camouflage on goal and a part of system design and are accompanied by it and there is no need for any action of military forces for applying it. The systems which are in the first stages of design have the best conditions for adopting surface treatments strategies. Geometrical forming is one of the most important methods of surface treatments which is achieved with the following criteria (table 1);

Remarks	index	Criterion
The larger the cross section the more the radiant radar energy toward the reflected signal place and the easier the identification of goal	Downsizing and reducing radar cross section	Target dimensions control
-	Low height	
Preventing application of electrically conductive surfaces such as metals and glasses with radar reflection, flat surfaces and surfaces with perpendicular sides prevent scattering of radar waves.	Radar waves scattering and deleting radiations of systems against sensor	Target form
-	Considering target less important (face transformation)	
Showing large goal as some small goals /dispersion		
It means separation or transformation of building, prevention of equal repetition of buildings and construction of uniform buildings because order is a sign of manmade objects and disorder is a sign of nature.	Creating failure and deletion of geometrical regular forms and reduction of other signs	
Homogenization is made possible by similarity to the surrounding environment.	Homogenization with environment	

Table 1: strategies of geometrical forming as one of the surface treatments methods

- Add – On Camouflage is used for the systems which have existed before. This is done by two kinds of substance:

³ One of the principles of passive defense in different texts is principle of hardening the vital structures which has not been mentioned in this research due to the absence of representation in urban spatial structure.

- Natural substances of camouflage include plants and soil (plant vegetation) : green space causes to reduce vision and enemy identification and attack factors and adjust explosion wave and vulnerability (Saeedi and Iran Doost, 2011).
- Synthetic substances of camouflage include artificial and semi-natural supplements, isogam and sound and electromagnetic insulation .

Principle of concealment

Concealment means being hidden from the vision of enemy and is a location based on passive defense of which basis is correct settlement in natural and built environments. Concealment methods include (Movahedi Nia, 2005) and (Boozari, 2009):

- Use of morphologic factor for making the target buries or semi-buried; it will be easily possible to identify installations in extensive plains and zones without geographic feature because they lack passive defense considerations (unsuitability of zones without natural reliefs for establishment of equipments, construction of installations and construction of shelters and safe places). Therefore, this will be possible by using natural valleys and earth cracks inside the internal tunnels, grooves, in shelter of highlands, natural reliefs and hiding surfaces difference. In passive defense considerations especially in concealment or secretiveness, it is common to use fault cliffs and fault valleys because these structures prevent from targeting equipments. For example, in Korea, museums have been constructed inside the mountains in order to protect cultural monuments. In European countries, serious efforts have been made to hide infrastructural installations such as power plants.
- Creating visual barriers and concealing them in natural and built shades as factor of light reflection reduction and difficulty of tracking.

Principle of deception

Identification of strategic goal difficult. Theory of deception is based on the fact that vital part of the set should be transferred to another part or appropriated to open space (Hashemi Fesharaki and Araghi Zadeh, 2011).

Principle of separation and prevention of vital systems interdependence

Separation of the vital systems from each other guarantees survival of city in case of failure of its part. This is possible by parallelizing and predicting the alternative systems (Movahedi Nia, 2007).

Principle of dispersion

Among principles of passive defense, dispersion is more related to urban spatial structure. Dispersion of important urban activities in this field has two main applications (Mir Ahmadi and Yadegar Zadeh, 2011):

- Reducing ability of enemy to recognize, target and penetrate into key, important and critical points at critical times; abundance and dispersion of urban centers cause to use more defensive forces.
- Guaranteeing survival of city in case of failure of its part due to dispersion of urban elements and infrastructures ; in old Iran, of the defensive strategies for reducing vulnerability are dispersion of services by creating servicing hierarchy in district, regional and urban scale and self sufficiency of the districts.
- Multi-functionality of urban elements

Creation of dual purpose structures which can have defensive function in addition to ordinary function is one of the principles of passive defense. By making dual purpose structures, construction cost of public shelters will be saved and shelters will not be deserted (Movahedi Nia, 2007). Of the strategies used for this purpose in different countries are use of urban subway as public shelter⁴ and development of green and open spaces which help conceal the region in addition to role of shelter at critical times.

Principle of access and penetrability

⁴ Shelter is the place which is more secure against different effects of weapons on ordinary buildings or open space (Movahedi Nia, 2005).

Transportation networks should be designed and reinforced such that it is possible for the public to exit and have access to relief in emergency.

3.2 Explaining elements of urban spatial structure

Organizing the urban spatial structure based on principles and strategies of passive defense in order to reduce vulnerability and increase sustainability is very important in issues of urban planning. Access to sustainable spatial structure requires identification of different elements of urban spatial structure. In this research, the studied elements of urban spatial structure were identified as follows:

- urban spatial development pattern
- spatial dispersion and layout of urban elements in the entire set (principles of strategies performances)
- juxtaposition and combination of different urban activities and performances (use of space, compatibility and proximity)
- accumulation, population density and activity at one place
- relationship between elements and performances (condition of communication network)
- space morphological subjects
- Organizing the urban spatial structure based on principles of passive defense requires identification of effects of passive defense principles and criteria on elements of urban spatial structure.

3.3 deducing spatial representation of passive defense principles and criteria in elements of urban spatial structure

Deducing spatial representation of passive defense principles and criteria is the final step in formulation of spatial logic of urban development based on defensive considerations. In this regard, effort is made to search for spatial representation of each passive defense principle in urban spatial structure which comprises of elements elaborated in the previous chapter. Result of the performed search is shown in table 2. This table is also regarded as a framework for measuring vulnerability of spatial structure of Tehran metropolis from the viewpoint of passive defense principles and criteria by giving arbitration tools.

4 MEASURING VULNERABILITY OF SPATIAL STRUCTURE OF TEHRAN METROPOLIS BASED ON CIRCUMSTANCES OF PASSIVE DEFENSE

Measuring vulnerability of spatial structure of Tehran metropolis in the first step requires identification of status quo of Tehran metropolis based on circumstances and principles of passive defense. At the end, conformity of urban spatial structure with spatial representation of passive defense principles and criteria which was explained in table 3 indicates vulnerability of spatial structure of Tehran metropolis.

4.1 Measuring Vulnerability Of Tehran metropolis based on principle of camouflage

Generally, Tehran metropolis with only 2 % of buildings with more than 9 stories and average compaction of two stories is the shortest capital in the world. However, Tehran city recently has seen construction of long building without planning and without observance of many passive defense requirements especially for vital and important governmental and public activities which has converted high rise building to an element contrary to sustainable development in urban development. Although it is cost effective to construct distinguished high buildings in globalization era and due to expensiveness of land in large cities, this case is not justifiable in the militarily threatened cities (Briggs, 2005). Generally, most of the governmental and public buildings in Tehran are relatively higher than their surrounding environment and this makes the target more important and facilitates its identification. One of the other weaknesses of Tehran metropolis is to expand large public and governmental buildings. National Iranian Library with approximate area of 9.7 hectares which has been constructed on hill in addition to its large scale is one of these examples. Another example is Tehran Mosalla complex located in southern side of Abbas Abad lands, although expansion of green space of Abbas Abad lands around these spaces is a potential for camouflaging them (figure 1).



Figure 1: a view of National Iranian Library building (derived from Google Earth software)

Use of uniform repetition of buildings (construction of uniform buildings) is one of the other subjects studied in this field. Residential and modern and future high buildings beside Evin Hotel (figure 2) and Ekbatan Residential Complex as the fourth Strategic Rings are of these class. Construction of spaces with geometrical and regular shapes facilitates identification of target from the surrounding environment.



Figure 2: a view of future buildings (derived from Google Earth software)

In morphological terms, weakness of Tehran metropolis is expansion of use of glass and aluminum view of office and governmental buildings due to easy installation and low cost price and this facilitates scattering of radar waves and identification of target. The known glass building of Ministry of Agricultural Jihad located in Keshavarz Blvd. as one of the first strategic rings and building of Bank Markazi (figure 3) have this feature.



Figure 3: a view of Bank Markazi building

spatial representation of passive defense principles and criteria in urban spatial structure					assive defense principles and criteria		
elements of urban spatial structure					Index	Criterion	Principle
Morphological subjects	Accumulation and density of population and activity in one place	Juxtaposition and combination of different activities and performances	spatial layout and scattering of performances in the complex (principles of strategic performances settlement)	Urban spatial development pattern			
<ul style="list-style-type: none"> Preventing expansion of vital and critical large-scale centers Small grading of uses 	<ul style="list-style-type: none"> Determining optimal scale of population settlement and activity in space Reducing the price and downsizing residential units 	-	-	-	Downsizing and reducing radar cross section	Target dimensions control	Surface treatment camouflage
-	<ul style="list-style-type: none"> Preventing high rise building of vital and important installations 	-	-	<ul style="list-style-type: none"> Emphasis on urban sprawl 	Low height		
<ul style="list-style-type: none"> Preventing application of electrically conductive surfaces such as metals and glasses with radar reflection in view of strategic buildings. Preventing application of flat surfaces or the surfaces with perpendicular sides 	-	-	-	-	Radar waves scattering and deleting radiations of systems against sensor	Target form	
<ul style="list-style-type: none"> equality and harmony of form of relief and environment 	-	-	-	-	Considering target less important (face transformation)		
<ul style="list-style-type: none"> preventing uniform repetition of buildings and construction of uniform buildings 	-	-	-	-	Creating failure and deletion of geometrical regular forms and reduction of other signs		
-	-	-	-	-	Homogenization with environment		
-	-	-	<ul style="list-style-type: none"> layout of critical and vital activities in green space 	-	Add - On Camouflage		
<ul style="list-style-type: none"> Preventing construction of symbols, signs and indexing 	-	<ul style="list-style-type: none"> Separation of vita activities from signs such as installations, main communication networks 	<ul style="list-style-type: none"> Preventing layout of important structures in large plains and zones without relief Settlement of important activities in tunnels, grooves, highlands, natural reliefs 	<ul style="list-style-type: none"> Making structure of city uniform with the surrounding areas and making determination of urban border difficult 	Concealment		
<ul style="list-style-type: none"> Necessity for avoiding difference of physical organization of vital activities of the surrounding texture 	<ul style="list-style-type: none"> Reinforcing surrounding residential places of large cities as deception and delay barriers 	-	-	<ul style="list-style-type: none"> Decentralizing and accepting polycentric development 	Deception		
spatial representation of passive defense principles and criteria in urban spatial structure					assive defense principles and criteria		
elements of urban spatial structure					Index	Criterion	Principle
Morphological subjects	Accumulation and density of population and activity in one place	Juxtaposition and combination of different activities and performances	spatial layout and scattering of performances in the complex (principles of strategic performances settlement)	Urban spatial development pattern			
-	<ul style="list-style-type: none"> Reducing interdependence of different districts by establishing required services in the district (districts independence potential) Preventing population increase and emphasis on dispersion approach 	<ul style="list-style-type: none"> Establishment of compatible uses in space Relative separation of business centers from residential centers Farness from hazardous production centers 	<ul style="list-style-type: none"> Creating hierarchical structure and centrality (district, local and regional centrality) of urban services 	<ul style="list-style-type: none"> Focus on suburban sprawl pattern, Avoiding application of linear development pattern and disruption of relationship between different parts of the city 	separation		
-	<ul style="list-style-type: none"> Decentralizing and transferring strategic centers to urban suburbs and appropriation of Central Business Districts to less strategically important activities Reducing charismas of central and critical business districts for establishing residential texture and encouraging to transfer them to suburbs of cities Necessity of uses distribution in urban structure such that it prevents centralization in gravity points of the city 	-	<ul style="list-style-type: none"> Creating servicing hierarchy with emphasis on neighborhood units patterns 	-	Dispersion		
-	<ul style="list-style-type: none"> Increasing openspace in the entire surface of residential sections as the factor increasing efficiency of the texture at time of accident 	<ul style="list-style-type: none"> Making dual -purpose public spaces for building shelters Building common tunnel of underground installations 	-	-	Dual purposes of space /multifunctional urban elements		
spatial representation of passive defense principles and criteria in urban spatial structure					assive defense principles and criteria		
elements of urban spatial structure					Index	Criterion	Principle
Morphological subjects	Accumulation and density of population and activity in one place	Juxtaposition and combination of different activities and performances	spatial layout and scattering of performances in the complex (principles of strategic performances settlement)	Urban spatial development pattern			
<ul style="list-style-type: none"> Increasing the barren and green lands and plant vegetation in city City fortification 	<ul style="list-style-type: none"> Closeness of collective spaces to open spaces with low confinement Urban density distribution in resistant and accessible districts 	<ul style="list-style-type: none"> Closeness to green and open environments, therapeutic and hospitals centers, firefighting centers and police stations for establishing security Farness of residential centers from fuel tanks, military bases, the desired targets of enemy including management and governmental centers 	<ul style="list-style-type: none"> The presence of suitable and homogenous communication network by creating a network of equivalent ways relating to other districts of the city Establishing vital activities in main communication routes Hierarchical structure of communication network and limiting easy access to residential places 	<ul style="list-style-type: none"> Preventing acceptance of galaxy development pattern⁵ Accepting chess development instead of organic development in design of communication network Increasing entrances and exits of the city 	Access and penetrability		

Table 2: spatial representation of passive defense principles and criteria in urban spatial structure –writer

⁵ Galaxy development is defined as development between expanded and centralized city in open and relatively small units and density is maximal in centers. In this kind of development, penetration into the city is easily done due to abundant open and green spaces between urban knots

In addition to these weaknesses, one of the weaknesses of spatial structure of this metropolis is development of city with average density of two stories.

4.2 Measuring Vulnerability of Tehran Metropolis based on Principle of Concealment

Attribution of bleak city to Tehran as 700-cubic km capital of Iran with all disadvantages from the viewpoint of city development management and planning has some advantages from the defensive viewpoint. Tehran is attached to Shemiranat and Rey under the best condition but a more careful look shows this urban giant geographically in touch with adjacent cities, estate and counties. Robat Karim, Eslam Shahr and Shahre Ghods have been separated from Tehran only with streets and highways which indicate a part of this borderless metropolis. Recently established Alborz Province is adjacent to Tehran only with a short road and border of Tehran metropolis is not easily distinguished from the surrounding districts.

One of the weaknesses of Tehran relating to principle of concealment is widespread tendency to indexing and construction of symbols and signs (figure 4). After attack of twin high buildings in 11 September, it seems that skyscrapers have lost their attraction in developed countries because terrorist is aware of power symbols (Briggs, 2005).



Figure 4: tendency to indexing in Tehran metropolis (derived from Google Earth software)

Layout of important and vital installations in large plains without relief is one of the other weaknesses of Tehran metropolis in this field. In this regard, one can refer to location of Milad telecommunication tower or Bagher Shahr power plant in southern plains of Tehran.

4.3 Measuring Vulnerability of Tehran Metropolis Based On Principle of Deception

Tehran as capital is highly vulnerable as industrial –administrative pole of the country due to centralization of main industries and ministries and important administrative centers. On the other hand, major economic activities of the city are located in its central zone.⁵ Generally, contemporary spatial structure of Tehran can be typologically imagined in “centralistic, single centric and dispersed radial “framework (figure 5). In recent decades, centralistic trends have led to intensification of single centric system of Tehran city. This trend led to more domination of main center of Tehran which is slipping and creeping toward north (Boom Sazgan Consulting Engineers, 2006). While there is principle of being outstanding in central development pattern which facilitates recognition of strategic business centers due to the growth pole. Therefore, one should transfer the complex to another part using theory of deception or appropriate it to open space (Hashemi Fesharaki and Araghi Zadeh, 2011).

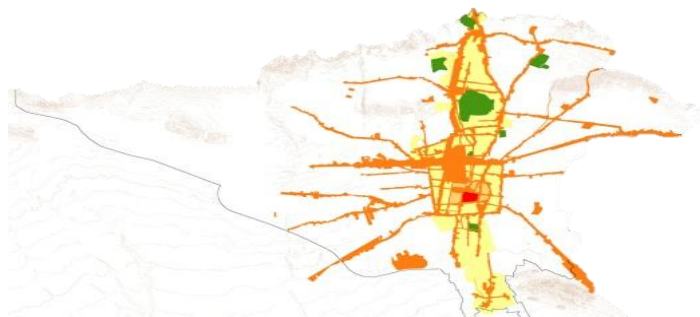


Figure 5: centralization of the most important urban settlement centers in northern-southern axis direction (Boom Sazgan Consulting Engineers, 2006, Tehran master plan)

⁵ Central zone is defined as distance between Valiasr , South Karegar Streets and Shahid Rajaei Highway from the west and Shariati , 17 Shahrivar and Shahrzad Streets from the east.

Another issue in this regard is economic, administrative and servicing weakness of the surrounding residential places around Tehran and their use as barriers makes deception and delay impossible. However, abundance of equal urban centers makes enemy's deception possible.

4.4 Measuring Vulnerability of Tehran Metropolis Based on Principle of Separation

Chaotic mixture of critical business centers in residential textures and zones is one of the weaknesses of spatial structure of Tehran metropolis. In this field, several cases are explained:

- Preventing observance of industries and residential texture proximity (industrial zone of district 21, industrial zone of eastern District 4, business centers around Khavaran Road etc).
- Proximity of political activities of the country such as Beit Rahbari and parliament to residential texture
- Proximity of Milad therapeutic center as one of the largest therapeutic centers of the country to Milad Telecommunication tower which makes its identification easier.
- Location of military region in east and its proximity to residential texture.
- Location of gas stations to residential zones.
- Location of power plants such as Bagher Shahr adjacent to residential texture.
- Others

Of the other weaknesses of Tehran metropolis are location of business-service centers on arterial axes generally and expansion of the most important business centers in national scale across main northern-southern axis because linear development doesn't cause to enjoy districts independence potential though which other parts continue functioning in case of failure of one part and efficiency of the dependent performances is reduced in case of failure of some main axis of the city. This will be aggravated by continuation of radial structure of Tehran metropolis. Other challenging issues in principle of separation in Tehran metropolis are interdependence of different districts despite history of self sufficient districts and failure to observe minimal safe distance between the residential buildings.

4.5 Measuring Vulnerability of Tehran Metropolis Based On Principle of Dispersion

Dispersion of important urban activities causes increase of security and sustainability of city despite increase of servicing costs due to reduction of enemy's ability to recognize, target and penetrate into important points, necessity of use of more defensive force due to abundance and dispersion of urban cities and guarantee of survival of city in case one part fails. Galaxy development and urban sprawl patterns are preferred over other urban physical development patterns. Centralistic spatial structure of Tehran city is vulnerable from this viewpoint.

4.6 Measuring Vulnerability of Tehran Metropolis Based On Principle of Multifunctional Urban Elements

One of the defensive strategies applied in old Iran in order to reduce vulnerability of city is the presence of multifunctional urban elements such as aqueduct which has played role of shelter as underground communication way between districts in addition to its main role at time of enemy attack. Hosseinies played role as district defense centers at any place at critical times (Mir Ahmadi and Yadgar Zadeh, 2011). In other parts of the world, Russians take action regarding creation of the required shelter as masters of passive defense and multipurpose designers of spaces redundancy when length of metro lines increases. Safe Swiss Metro with suitable depth, Pyongyang dual-purpose Metro in North Korea with depth of 90-105 m are the good examples (Maleki and Zarifi, 2011). Of the weaknesses of Tehran metropolis are insufficient coverage of metro lines and avoidance of its settlement in suitable depth for playing role of shelter (figure 6).



Figure 6-the present and future rail lined of Tehran city (Boom Sazgan Consulting Engineers, 2006).

One of the other strategies in this field is use of open and green space in the city (figure 7) which is not available in Tehran metropolis.



Figure 7: layout of large-scale green space among Moscow urban texture

4.7 Measuring Vulnerability of Tehran Metropolis Based on Principle of Access and Penetrability

Incomplete communication network and especially Tehran metropolis highway network and discontinuous performance of the network, unsuitable access in some parts of the city especially the decays as well as important business centers of the city make servicing difficult at time of threat. Of the other weaknesses of spatial structure of Tehran metropolis is layout of high buildings in low penetrable regions. Establishment of the most important business centers across main arteries facilitates access and relief despite some disadvantages. Abundance of entrances and exits of Tehran metropolis is one of the strengths which allow the population to immediately exit (figure 8).

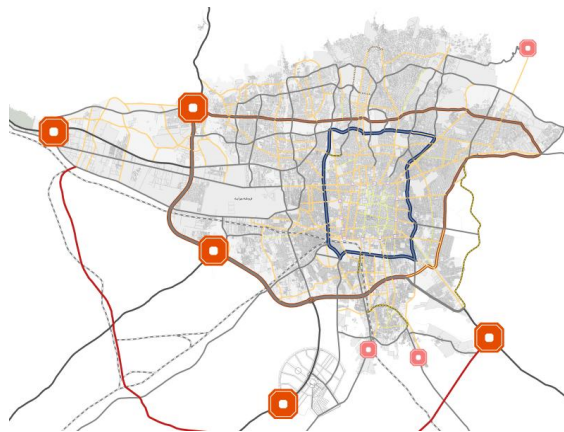


Figure 8: dispersion of exits and entrances of Tehran metropolis (Boom Sazan Consulting Engineers, 2006)

5 FORMULATING SUITABLE SPATIAL DEVELOPMENT POLICYMAKING FRAMEWORK AND PRESENTING VULNERABILITY REDUCTION WAYS

Result of the performed studies, vulnerability of spatial structure of Tehran metropolis is summarized in table 3. The hachured cells indicate vulnerability grounds and grey cells indicate sustainability grounds.

Spatial representation of defensive principles and criteria in spatial structure					Passive defense principles and criteria		
Elements of urban spatial structure					Index	Criterion	Principle
Morphological issues	Accumulation and density of population and activity	Juxtaposition of activities and performances	Layout and distribution of performances in complex	Urban spatial development patterns			
					Downsizing and reducing radar cross section	Target dimensions control	Surface treatment camouflage
					Low height		
					Radar waves scattering and deleting radiations of systems against sensor	Target form	
					Considering target less important (face transformation)		
					Creating failure and deletion of geometrical regular forms and reduction of other signs		
					Homogenization with environment		
					Add - On Camouflage		
					Concealment		
					Deception		
					separation		
					Dispersion		
					Dual purposes of space /multifunctional urban elements		
					Access and penetrability		
Sustainable	Vulnerable		Without proof		Table guide		

Table 3: measuring vulnerability of spatial structure of Tehran metropolis based on defensive circumstances-writer

High vulnerability of Tehran metropolis to threats clarifies necessity of formulating suitable policymaking framework . In this regard, vulnerability reduction strategies have been suggested in each one of the studied axes:

- Strategies of fulfilling principle of camouflage
 - Constructing vital underground centers and installations; in Sweden, power generation, fuel reserves and necessary procurement centers have been laid out in the underground (Maleki and Zarifi, 2011).
- Strategies of fulfilling principle of concealment
 - Using river five northern –southern valleys of Tehran city in order to decentralize nonresidential performances in zone of northern –southern continuous axes and using their privacies as protective green space; in wrinkled regions , erosive performance of synclines causes formation of broad valleys or confirmed plains of which abundance facilitates dealing with principle of dispersion in passive defense(Boozari, 2009).
 - Preventing construction of symbols, signs and indexing –using few high symbols
- Strategies of fulfilling principle of deception
 - Accepting urban dispersal strategies, Tehran center refinery and promoting its functional level and quality for cultural, touristic and recreational performances; in Tehran, most of large enterprises are governmental and strategy of decentralization and transfer of important centers to suburb districts and appropriation of central spaces to the activities which are of less strategic importance (such as coffee shops and galleries) is the best strategy.
 - Reinforcing polycentric pattern and equivalent urban centers in urban spatial structure by prioritizing equipment of peri-urban centers of Tehran and new satellite towns and

transferring administrative and political centers to peri-urban centers ; concurrently with start of Tehran Regulatory Plan enacted in 1991, chaotic condition of Tehran led some authorities to think about transfer of capital and some studies started in this field resulting in long time (15 to 25 years) and heavy expenses of transfer which dissuaded the authorities to do so(Boom Sazgan Consulting Engineers, 2006). Now, policy of transferring administrative capital to Parand seems to be a suitable strategy in this regard.

- Accepting decentralizing patterns in spatial structure of Tehran metropolis; among different urban development patterns, centralistic forms due to easy identification and failure of main functions of city are the most vulnerable and on the contrary, decentralist forms are the least vulnerable due to difficult identification of business centers (Mir Ahmadi and Yadegar Zadeh, 2011).
- Strategies of fulfilling principle of separation
 - Emphasis on neighborhood units approach and independency and self sufficiency of districts
 - Relative separation of business centers from residential zones and observance of compatibility principle in layout of activities and prevention of creation of hazardous installations in public centers and transfer of these installations to outside the city
 - Observance of minimal distance between residential buildings and coverage of open space by green land use
- Strategies of fulfilling principle of dispersion
 - Emphasis on urban sprawl pattern ; less density of population reduces vulnerability and increases attack cost(Ebrahimi, Mobin Rahni, 2010), though increase of density will not be effective on vulnerability dependent on place(Saeidi and Iran Doost, 2011). Authorities of this field believe that recent terroristic attacks on urban centers of America facilitate urban scattering toward the margin such that this country will see intensive increase of life rate around the city and decentralization of business centers (Ziegler, 2005). Suitable scattering of masses by changing to polycentric, multiplex and network⁶ development patterns; polycentric systems are more sustainable due to variety because there is substitute for it in case of failure of one of these centers (Marcuse, 2002).
 - Refining the present business zones and expanding fields of activity in domain of Tehran city and peri-urban development; edge cities form the future spatial development pattern due to benefits of passive defense (Ziegler, 2005). Tehran will be forced to move toward a regional multi-centered business environment in order to fulfill principle of sustainability and security. In this way, more independent vital enterprises in urban centers which have internalized large part of their external benefits move toward less dense urban fringes and the activities which are not dependent on communication media and modern transportation technologies remain in center. After 11 September, many main enterprises in New York possessed large satellite departments in urban fringes (Marcuse, 2002).
- Strategies of fulfilling principle of multifunctional urban elements
 - Increasing flexibility, variety and efficiency of urban spaces
 - Increasing length and depth of metro lines and equipping it as shelter, including shelter for a city with population of 4000 and area of 600,000 cubic meters and one can construct 150-km tunnel in underground depth which is accessible to the public. By designing safe

⁶ Typologically, this structural change can be regarded as movement toward network pattern. In this pattern, hierarchy is not only regarded as key and critical concept but also attempt is made to give any part of city identity by distributing centrality and density in large scale and by covering the metropolis resulting in its special and suitable performance without it is regarded less important or more important than other parts. Therefore, abundance of the related, complementary and distributed centers in the city level, formation of abundant functional and physical barriers, varied and balanced transportation system and finally functional and multilayer balance can be regarded as main features of network spatial structure.

multipurpose structures such as metro, underground shops, construction cost of public shelters will be saved and shelters will not be deserted (Movahedi Nia, 2005).

- Strategies of fulfilling principle of access and penetrability
 - Observing hierarchy in structure of residential place and communication network ; in the past, observance of hierarchy of access, organic structure and narrow passageways, dense urban texture have made penetration of immigrants impossible (Mir Ahmadi and Yadegar Zadeh, 2011).
 - Reinforcing transportation network based on astral and radial patterns in order to facilitate exit of the population.
 - Layout of squares and local gathering spaces in urban texture with rapid accessibility to residents; proximity of collective spaces to open spaces with low confinement reduces resistance of space against war injuries (Saeidi and Iran Doost, 2011).
 - Fortification of city and public places: public places should be less public and their free access and use should be limited. Instead, controlled spaces such as large shops have increased their attraction in this regard (Marcuse, 2002).
 - Easy access to business centers by arranging activities as abundant and integrated centers.
 - Attention to principle of easy access in location of high buildings.

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