Passive defense: Measuring and evaluating urban vulnerability with resilience approach

Defensa pasiva: medición y evaluación de la vulnerabilidad urbana con un enfoque de resiliencia

Mohammad Rezaie Narimisa*
Ministry of Petroleum - Iran
mrn43000@gmail.com

Noor Ezlin Ahmad Basri**
National University of Malaysia - Malaysia
neab8693@gmail.com

Malek Elahi***
City of Malabaon University - Philippines
shayanrad57@hotmail.com

Mohammad Hasannezhad****
Shahid Beheshti University - Iran
shayanrad57@hotmail.com

Elham Alipanahi*****
Ruzbahan University - Iran
shayanrad57@hotmail.com

ABSTRACT

The purpose of the present research is to measure the level of urban safety based on the principles of passive defense, urban leveling based on the degree of vulnerability, the urban infrastructure dispersal pattern and important decision-making organizations in the city. The study is based on the urban environment, which has been used to measure the vulnerability of the city during the onset of war by using spatial indices influencing safety.

Keywords: passive defense, vulnerability, ANP, AHP, Arc GIS

RESUMEN

El propósito de la presente investigación es medir el nivel de seguridad urbana basado en los principios de defensa pasiva, la nivelación urbana basada en el grado de vulnerabilidad, el patrón de dispersión de la infraestructura urbana y las importantes organizaciones de toma de decisiones en la ciudad. El estudio se basa en el entorno urbano, que se ha utilizado para medir la vulnerabilidad de la ciudad durante el inicio de la guerra mediante el uso de índices espaciales que influyen en la seguridad.

Palabras clave: defensa pasiva, vulnerabilidad, ANP, AHP, Arc GIS.

*Ministry of Petroleum, National Iranian Oil Refining & Distribution Company, Oil Refining Industries Development Company, Tehran, Iran (Corresponding author)
**Professor of National University of Malaysia (UKM), Department of Civil & Structural Engineering, Faculty of Engineering & Built Environment, Malaysia
***City of Malabaon University, School of Graduate Studies, Metro Manila, Philippines
****Assistant professor of Shahid Beheshti University, Financial Management and Accounting Department, Tehran, Iran
*****Department of Architecture, Ruzbahan University, Sari, Iran

Recibido: 08/01/2019 Aceptado: 01/03/2019

Introduction

Civil defense was created during World War II and in efforts to counter the air strike, provides shelter and alert civilians. According to various US Department of Defense sources, passive defense is a set of measures taken to reduce vulnerability and minimize the potential damage caused by the attack of enemy forces (2). Some of the measures that can be taken include early and timely warnings, dispersal, protection of important individuals and the general public, medical assistance, in particular to counteract and reduce the deadly effects of nuclear, biological and chemical attacks, weapons of mass destruction, staff training And tactics and processes that effectively reduce the damage caused by enemy attacks. In today's wars, it is imperative to take non-operational measures to counter enemy attacks and to reduce the damage caused by air, land and sea attacks (4), which is the key to all key infrastructures, vital, critical and important military and civilian centers, such as refineries, Power stations, ports, airports, large industrial complexes, military and political headquarters (6), communication centers, strategic bridges, military industries, air bases, missile sites, crowded centers and tactical headquarters, support and defense headquarters, and so on.The passive defense approach is based on all civilian principles and practices that prevent or minimize financial losses to vital and critical military and civilian facilities and financial and humanitarian casualties (8). Therefore, the attention of the leaders and officials of each community to non-combatant schemes provides the necessary grounds for advancing this new approach to promoting the concept of urban safety and security. The passive defense structure does not reduce the likelihood of a crisis and incident, but reduces the amount of damage to the exposed elements (10).

One of the most important dimensions of social welfare, safety and comfort is the potential danger. Providing safety in urban spaces is subject to decision making in urban construction and design patterns, tailored to different human groups and ecosystem characteristics of each area (Alexander, 2002). Given the importance of using inactive passive principles that protect people's lives in times of crisis, the value of some urban parameters affecting the crisis, such as the opening or closure of space, the density or dispersion of urban settlements and functions, the distance from sensitive uses, proximity to spaces (Eckert, 2008), and Safe applications, prediction of shelters in different parts of the city, multi-core urban centers against dependency on a center and other indicators of construction and urban design (Karbasian, 2011).The purpose of the research is to investigate and analyze the natural and human factors influencing the city's vulnerability from the perspective of passive defense. Natural features affecting the city's safety include geographical location, slope, existing faults, surface waters, annual rainfall, and so on (Nikoomanesh, 2014). In terms of man-made properties, housing, urban facilities and facilities, transportation and traffic, critical sites, urban centers of gravity, security-security locations, safe spaces and warning signs at the time of the incident can be mentioned (Shakibamanesh, 2015).The following research questions are: 1) What are the important spatial and spatial metrics in urban areas in accordance with the principles of inertial defense? 2) According to the research indicators, what is the status of urban vulnerability in contrast to possible attacks?

One of the most important theories related to passive defense is the theory of five loops and the Carver matrix theory. The theory of inspiration derives largely from Karl Clausewitz's thoughts, called the Strategy of Gravity Centers. Clausewitz believed that the first task in planning the war was to identify the enemy's centers

of gravity, and if these goals were not carefully and accurately selected, they would waste huge human costs, equipment and the loss of vital irreversible opportunities. Centers of gravity are centers that are the source of all the movements, activities and powers of the country invaded. Iman believes that the most important task in planning a war is to identify the centers of gravity of the country and if these centers are carefully identified and targeted, the invading country, in the first days of the war, would taste the defeat of the military and in the shortest possible time to the demands The invading country will surrender and surrender. The model of the five strategic engagement rings is precisely the invasion country as the human body's organs, so that if the brain and nerves (nerve centers, foodstuffs required for systemic and circulatory), limbs and legs (the motor system) The spirit and mind, the will and the defense system of the human body (defense cell) from human beings, will not be able to perform any activity and movement, if the five clashes in the country were destroyed by the invasion, he paralyzed him, defeated and surrendered his early will be.Another method of passive defense is the seventh criterion for choosing the best target from the enemy (Carver's Matrix Method). The criteria for the study, which are registered as an accepted and enforceable theory with various applications in the relevant sources, can be identified as Carver Matrix. The word "carver" is the first letter of the sixth criterion of prioritizing goals or choosing the best goal. These criteria include: target significance and sensitivity, target accessibility capability, ability to restore and restore target, target vulnerability, target impact, target detection capability, economic value of tanks and currency yields.

To determine each of the criteria in enemy attack scenarios, the seven criteria are scored on a scale from 1 to 10 based on its status for the enemy. Then, each of the scores derived from each benchmark is set in the final table, the goal with the highest score is the best target for the attack. In the course of further studies and further studies, another criterion, which is actually the seventh criterion, is added to the six criteria according to the economic value of the buildings and the return of its currency and its rivals, which is in fact the effect of the destruction of the target in the world's public opinion. Accordingly, terrorist and subversive operations are more important than critical, critical and critical infrastructure sites. These centers and facilities, which are largely dependent on centralized information technology systems, include demographic centers, telecommunication centers, energy supply facilities, electricity, water, food factories, transportation systems, and more. That's why the focus of terrorist acts on these types of networks has increased. In enemy's view, it is a vulnerable target with a diameter of 400 meters, such as an air base, a missile base, a large industrial complex, and so on. Based on the size of their location and degree of importance, the various vulnerable areas of the city are in table 1.

Table 1. Vulnerable infrastructure and related elements

Transport infrastructure	Roads, highways, lines and railway stations, subways, airports, pipelines include: natural gas transmission lines, crude oil and other hazardous materials.
Oil and gas production and accumulation infrastructure	Main crude and natural gas reservoirs, storage facilities and refined oil and gas tanks, refineries and petrochemical and chemical plants

Water supply infrastructure	Dams, municipal water tanks, storage facilities, refiners and transmission systems including pipelines and cooling systems
Emergency Services Infrastructure	Hospitals, health centers, police stations, fire centers, relief and rescue centers
Public-Cumulative Infrastructure	Hotels, hospitality, shopping malls, recreational and tourism centers, religious places, cold stores, wheat silos, factories and food depots

Methodology

In this study, applications were categorized into 11 main categories to measure vulnerability. Given the super matrix's attitude, most notably known as the Analytical Network Process (ANP), it is an attractive tool for better understanding of decision making and overcomes the constraints of hierarchical structures. Therefore, the ANP model was used to evaluate the applications. Such a system can be represented by a directed grid, in which a surface or cluster may, directly or indirectly, also be affected by other features of the decision (or elements) and surfaces (or clusters), and also influence. The emphasis in this research is on some of the principles of inactive defense, which has been tried to evaluate and analyze various layers in the statistical and graphical software environment according to these scales.The reason for choosing an ANP method for measuring the criteria and sub-criteria is that in addition to verifying the goals, criteria, sub-criteria, and finally the options, to measure horizontally all items together and each option with the same according to the research model. Based on this, we first compared and evaluated the eleven users, and then the intra-group criteria of each indicator were compared. The way of valuation and importance of applications and information layers has been done in two steps. In the first step, the main applications with each other and the subcomponents of each group are also combined with the ANP model in the Super Decisions software environment. In the second step, the 20 layers of information that have played the most role in the discussion of vulnerability and passive defense have been extracted. Their vector maps are converted into lattice layers in the ArcGis software environment, and then the scores of each layer are evaluated with the help of the AHP model in the Expert Choice software environment and, accordingly, the importance of each layer is taken into account in the final selection of vulnerable and non-vulnerable locations. To evaluate and grade the criteria and sub-criteria and their role in safety, 10 of the non-urban civil defense experts who worked in various organizations, including law enforcement and housing and urban planning, have been used. Information layers are GIS maps that are extracted from urban detailed plans and evaluated and compared by experts.

Table 2. Vulnerable infrastructure and its related elements

Vulnerable infrastructure	Elements

Transport infrastructure	Roads and highways, lines and railway stations, subways, airports, pipelines including natural gas transmission lines, crude oil and other hazardous materials
Oil and gas production and accumulation infrastructure	Main crude and natural gas reservoirs, storage facilities and refined oil and gas tanks, refineries and petrochemical and chemical plants
Water supply infrastructure	Dams, municipal water tanks, storage facilities, refiners and transmission systems including pipelines and cooling systems
Emergency Services Infrastructure	Hospitals, health centers, police stations, firefighting centers and relief and rescue centers
Public infrastructure - people	Hotels, hospitality, shopping malls, recreational and tourism centers, religious places, cold stores, wheat silos, factories and food depots

Table 3. Dimensions and criteria of passive defense in urbanization

Dimensions	Definitions and measurement criteria
Miniaturization	Reducing the meaning of decentralization, the formation of urban centers and the establishment of various branches of the city. Having multiple locations as the city center instead of a specific location. Preventing the emergence of metropolises and the distribution of the population in the middle and small cities. Reduce the diameter of important buildings and buildings.
Optimal Scale	Attention to the hierarchy of urban activities and the definition of city, district, neighborhood, neighborhood and so on functions. Determine the optimal scale of population deployment and activity in space. The optimal distribution of gardens and green spaces on a wide scale, the breadth and hierarchy of communication networks.
Functional dispersion	Separating the expansion and diffusion of centers, facilities, equipment and facilities with various activities within a reasonable time to reduce their vulnerability to enemy operations. Distribution of population and national capital in the whole territorial space through the application of territorial policy and the dispersion of key and critical infrastructure. Avoiding points with population density and high construction density, lack of open spaces during congestion, central office centers, fine texture and so on. Proximity to open spaces, green space, access to the communication network, cobblestones and others.
Strengthening	Refers to structures designed to protect critical, critical, and critical facilities, in appropriate locations, in order to withstand bombs, rockets, missiles, bullets, etc., to prevent damage to persons, equipment and facilities It will neutralize the effects of cracking and explosion wave. Avoiding worn and damaged textiles, hazardous urban facilities such as gas lines, electricity, gas pumps, etc. Proximity to office buildings, refuges and dams. Buildings complying with architectural and urban standards, places away from faults and flood, places with a suitable slope, and so on. How to use and retrofit, instrumental and non-structural elements of the city to reduce the damage caused by the explosion.

Optimal location	The location of choice is the best and most desirable point and location, so that it can best conceal and hide the manpower, equipment and activities. Quality of urban form compatibility with applications, pedestrian network, cavalry, information network, etc. If urban neighborhoods are to be adhered to and noncompliant uses are not together, rapid depletion can be provided.
Multi-functional spaces	The possibility of multilateral utilization of urban and architectural spaces during the crisis, the creation of dual and sometimes multipurpose structures. In the city of Moscow, the design of spaces and indoor places of the city train system is such that in addition to moving in normal times, the ability to resettle and provide the necessary supplies of more than two million citizens for a period of about a month. Determine the geometric design of the building, the location of the openings, how to access, as well as predict the cases and determine the multi-functional space for each building at the time of the crisis.
Cheaping and Innovative	Paying attention to the profit-to-cost ratio, and the best response to other threats and the use of creativity for optimal use of features.
Permeability	In terms of access and physical and visual access between two points, the feature is used to describe the city's communication network and a definition for the readability of paths and the density of access in urban context. The number of potential paths from one point to another, the type of urban texture (planned or organic), the scale of the blocks, the order and the core of the communication network, the degree of confinement, the size of the texture, the filling and empty of urban spaces.
Homogenization	Creating a region or set with different layouts of various functions as an integrated body with a homogeneous background can disrupt the perception of unauthorized persons. The conventional methods in this regard are to make changes in the form, shape, type of access and appearance in a variety of ways, including the use of green space coverage.
independency	Each city in a region should have the ability to act independently at the time of the incident and not dependent on other cities (the center of the country or province) for the rescue or supply of food. At the urban level, other infrastructure of other neighborhoods (such as water, electricity, gas, etc.) should not be left open with infrastructure damage in particular neighborhoods.

Table 4. Comparative Measurement Scale

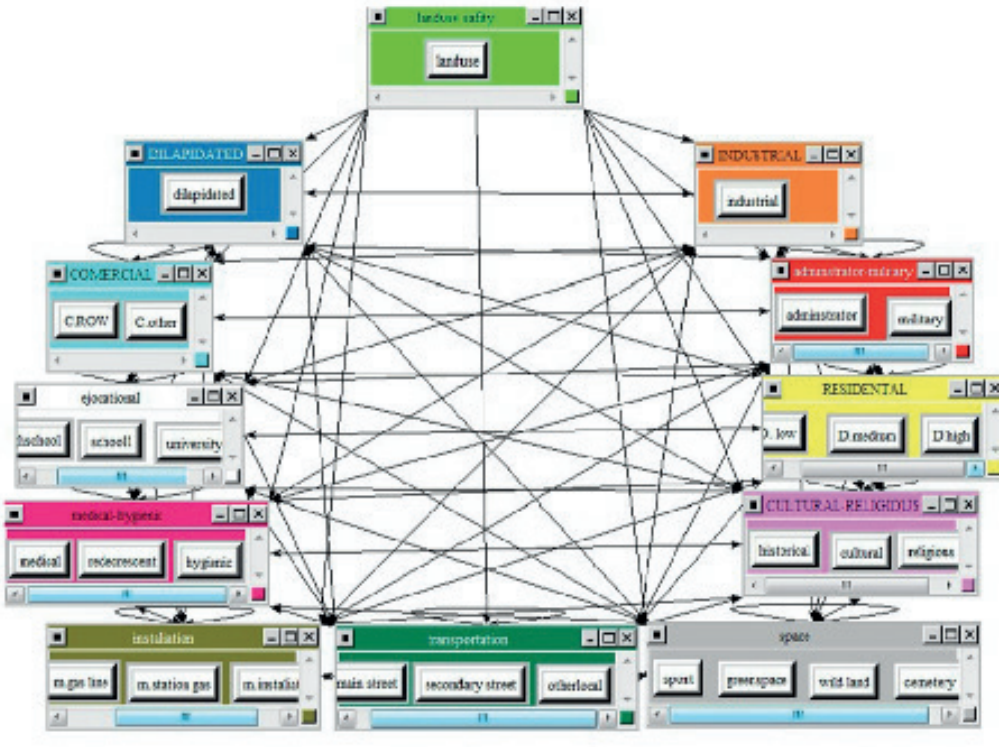
Dimensions	Definitions and measurement criteria
Permeability	In terms of access and physical and visual access between two points, the feature is used to describe the city's communication network and a definition for the readability of paths and the density of access in urban context. The number of potential paths from one point to another, the type of urban texture (planned or organic), the scale of the blocks, the order and the core of the communication network, the degree of confinement, the size of the texture, the filling and empty of urban spaces.
Homogenization	Creating a region or set with different layouts of various functions as an integrated body with a homogeneous background can disrupt the perception of unauthorized persons. The conventional methods in this regard are to make changes in the form, shape, type of access and appearance in a variety of ways, including the use of green space coverage.

independency	Each city in a region should have the ability to act independently at the time of the incident and not dependent on other cities (the center of the country or province) for the rescue or supply of food. At the urban level, other infrastructure of other neighborhoods (such as water, electricity, gas, etc.) should not be left open with infrastructure damage in particular neighborhoods.

Table 5. Valuation of the safety level of urban use during incidents

Description	Description	Description
The two elements have the same importance.	The same importance	1
An element has a modest advantage over another element.	Moderate advantage	3
An element is superior to the other element.	High excellence	5
An element has a great advantage over another element.	Awesome excellence	7
An element has an extraordinary superiority to the other element.	Extremely high superiority	9
Intermediate cases in judgment.	Intermediate values	2,4,6,8

Figure 1. Comparison of criteria and sub-criteria (primary and secondary uses) by using the ANP model in the Super Decisions software environment



Results

Comparison of applications in terms of safety Due to the nature of each user and its compatibility with the principles of passive defense, applications have a special value. This valuation is based on the Thomas Saaty 1 to 9.In the next step, in addition to comparing the main uses with each other, the nature of the ANP method is compared to the sub criteria of each major criterion.The value and importance of safety of some urban applications such as agricultural land, topographical effects, and urban green spaces is more than other uses, and some uses such as industrial units, gas networks and other facilities have the lowest score. In addition to evaluating the applications, according to the experts' opinion, the significance of the nineteen-dimensional coefficients was evaluated using the AHP model and the coefficient of significance of each layer in the ArcGis environment was multiplied in the layer. According to the comparison, the layers with the highest coefficient of significance include the following: urban land use (0.19), population density (0.14), military buildings dispersion (0.115), construction density (0/088) and the distribution of urban facilities (0.068). The Euclidean method has been used to estimate the distance from the layers.Validation based on distance from the six main layers provided by these layers includes roughness's, industries, sports fields, Red Crescent Center, health centers and green spaces. The distance obtained from the Euclidean method is obtained (the shortest distance between two points). Based on the Euclidean distance, 10 distances range from minimum to maximum.In addition to discussing the appropriateness of use and the distances from incompatible uses, the principle of lack of congestion, lack of focus and dispersion is very important. Accordingly, important administrative buildings should be distributed in such a way that the enemy with the least operational and military movements cannot cause serious damage to all buildings or the population is more exposed. So, by creating various branches, an important user can follow his or her normal life.

Considering the analysis of the values of inactive layers affecting the passive defense using the ANP and AHP statistical models, as well as the spatial analysis performed in the ArcGis software environment, the vulnerability of various urban neighborhoods has been determined and its results in six spectra with the titles of the vulnerability are very high, high, low, relatively low, low and very low. By studying the strengths and opportunities of urban safety, it will be determined that most of the parameters affecting safety improvement are related to natural features and urban macro foot, but in terms of building management and urban construction, dispersion and congestion, population spatial distribution, habitats and equipment Urban, transportation and communications have weaknesses and threats that can put the future of the city at risk. In other words, many urban decision-making and decision-making processes have not been appropriate in the process of distributing activities, services, and applying criteria. The city lacks any public shelter at the city level or the county seat defined in the residential units. The pattern of distribution of office buildings and decision-making centers is concentrated in three parts of the city, with an emphasis on the central part of the city. Although some units and military centers have been placed outside the city, some important centers and police decisions are at the provincial and city police headquarters in residential areas.

Table 6. Major and secondary user privileges based on safety appropriateness using the ANP model in the Super Decisions software environment

Percentage proportion	**Safety fit**	**Idiom**	**Sub categories**	**Main applications**
6	0,06	Administrator	Official	Administrative-law enforcement
3	0,03	Military	Law enforcement	
3	0,03	Economic Row	Business Axes	Commercial
1,8	0,018	Economic Place	Business locations	
1,1	0,011	Historical Structure	Historical buildings	Cultural-historical
3	0,03	Cultural centers	cultural centers	
2	0,02	Religious Structure	Religious buildings	
0	0	Dilapidated Structure	Ruined buildings	
2,3	0,023	High school	High school	Educational
2	0,020	School	Primary schools	
4,3	0,043	University Center	Academic Centers	
0	0	Industrial units	industrial units	Industrial
0	0	Secondary Gas line	Substation gas lines	
0	0	Main Gas Station	Main gas pipelines	
0	0	Main Gas Station	Important Gas Supply Stations	Facilities and equipment
0	0	Other Installation	Other urban facilities	
2	0,020	Hygienic Center	Health-Therapy	Health-Therapy
7	0,07	Medical Center	Health centers	
6	0,06	Low Density Constructional	Low build density	Construction density
2	0,02	Medium Density Constructional	Moderate construction density	
0	0	High Density Constructional	High build density	
7,5	0,075	Green Space	green space	Open spaces and natural elements
8	0,08	Agicuip	Farmland	
8	0,08	Topography	Natural obstacles (topography)	
6,7	0,067	Sport land	Sports grounds	
7	0,07	Wild land	Bayer land	
4	0,040	Cemetery	Cemetery	
6	0,06	Main Street	Main streets	communication network
3,1	0,031	Second Street	Second class streets	
0	0	Walk Ability	Marching paths	
2,7	0,027	Other Street	Other streets	
100	**1**	**total**		

BIBLIOGRAPHIC REFERENCES

Alexander, D. (2002). From Civil Defense to Civil Protection and back again. *Disaster Prevention and Management,* 11. No. 3, 209-213.

Brandon, P. (2011). Extreme Management in Disaster Recovery. *Journal of Procedia Engineering*. No. 14,Pp. 14-21.

3.Eckert, N and E. Parent and T. Faug and M. Naaim. (2008). Optimal design under uncertainty of a passive defense structure against snow avalanches: from a general Bayesian framework to a simple analytical model, Natural Hazards and Earth SystemSciences,8,Pp.1067-1081.

Excerpts from the Civil Defense Emergency Management Act of 2002 (New Zealand), No.33

Karbasian, M, Abedi, S. (2011). A Multiple Objective Nonlinear Programming Model for Site Selection of the Facilities Based on the Passive Defense Principles. *International Journal of Industrial engineering & Production Research*. Volume 22, Number 4: 243-250.

Mohsen, k. Zarei, S. Kalantari, M. and Soleimannejad, E. (2014). Criteria of Passive Defense in Subway Stations. *Journal of Civil Engineering and Urbanism*, Volume 4, Issue 3: 298-304

Nikoomanesh, M. R. Nazarkhah, A. and Panahyian, J. (2014). Study of the Methods of Passive Defense Implementation in the Energy Field and the Relevant Industries. *International Journal of Basic Sciences* & *Applied Research*, Vol. 3.

Saaty L. T. (2004). The Analytic network process dependence and feedback indecision making part2 theory and validation examples.

Shakibamanesh, A.(2015). Public shelters: Towards secure urban planning and designing in terms of passive defense. Malaysian journal of society and space 11 issue 3: 1-9

Yeganegi, K. and Bayat, E. (2012, *July 3 - 6*). Applicationof Passive Defense in Location of Industrial Estates.*Proceedings of the 2012 International Conference onIndustrial Engineering and Operations ManagementIstanbul, Turkey.*