# SUSTAINABLE LOCAL PLANNING FOR SUPPLYING PARKING SPACE IN RESIDENTIAL APARTMENTS IN ORDER TO BALANCING OF BARRIERS AND PROBLEMS CAUSED BY INCREASING BUILDING DENSITY

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*Received: 08 Feb. 2014*
*Accepted: 26 Apr. 2014*
*Published: 30 Apr. 2014*

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**ABSTRACT:**
It is obvious that in the machine related world, parking space is as important as other spaces in a building, then considering proper space for car parking in residence and activity place are essential. Automobile easy ownership and citizens' interest to use personal vehicles for different reasons increases the importance of this space in buildings. Despite of all planning that have been conducted to make more regulated parking space, especially in residential use in Rasht, related criteria have been violated that leads to marginal park of residents in two sides of streets and alleys that disturb comfortable pedestrians and car movement, or failing to provide parking conditions, dissuaded developers from apartments construction in city that needs compression due to urban population increasing rate and existence of agriculturally valuable lands. This study uses factor analysis method and extraction factor with both density and parking variables to confirm exacerbation of parking space shortage problem by increasing of building density. On the other hand, spatial analysis of noted factor indicates that certain parts of this neighbourhood, such as "Mojtame Golha" which is a complex of several blocks, have acquired an appropriate rank despite of high building density in terms of this factor. Results of this spatial analysis along with other field interpretation of physical, social and cultural conditions provide appropriate strategies in this regard.

**KEYWORDS:**
Parking Space, Construction Density, Compact City, Golsar Neighbourhood, Rasht

## INTRODUCTION

Considerable increase in urban population on one hand and its horizontal expansion and extensive development have consequences such as weakness in urban structure and system, lack of appropriate development, loss of high-quality agricultural lands, high costs of the infrastructure, etc. In recent decades, urban land transfer, incidence of marginalization, and eventually urban horizontal expansion have been caused major and serious problems on the one hand, and issues of sustainable development, urban management, preservation of agricultural land and gardens around and inside cities and increasing price of urban land and housing on the other hand, have made urban experts and managers to limit urban development and increasing of building density is one of effective methods. However, the experience of increasing of density as one-dimensional solution to prevent horizontal and uncontrolled expansion, created many serious consequences and problems and faded future city sustainable vision more than before. Construction development regardless of service and infrastructure capacity is one of major problems. Public and private parking space supply for growing population of urban areas is a serious shortage of unplanned urban growth. Lack of adequate parking space for urban blocks has traffic, physical, and social extensive consequences.

Undoubtedly, changing routine and localizing urban planning method regarding to specific environmental and geographical characters of each city could be effective to deal with this problem and other problems due to urban horizontal expansion. Although nowadays using of technological facilities which are expensive economically and also deleterious environmentally, environmental variable indicators dependent on location could be considered constant by urban planners, designers and architectures but concerning these local and geographical properties and effects of them on formation of settlements in terms of increasing and optimization of required urban qualities is not negligible. There is not any unique method for urban sustainable development. It is obvious that in searching to have a sustainable city, we should reach to a single form. Form of a city, settlement, or house can be effective on its sustainability, but this form can be sustainable locally but cannot be useful in city or region level. So, a form should be related to all geographical scales (neighbourhood, city, region, etc.) definitely.

Rasht, with specific climatic and geological characteristics and valuable and high potential

agricultural land for accommodate growing population in recent years, faces with increasing construction density that is a logical solution to prevent horizontal development of the city and using of valuable agriculture land for construction purposes. However, as mentioned above, this increase has negative consequences that supplying parking space is one of them. On the other hand, hardship of parking space supplying in underground leads to more difficulties because of geotechnical problem and high level of underground water. This study tries to achieve appropriate strategies that are tailored to particular circumstances of Rasht.

**Residential qualities associated with construction density**

Sustainable development concept, that has been introduced in world's scientific community since 1970s, could be consider as logical progress of a new awareness about global issues of environment and development which in turn had been affected by environmental movements of 1960s, publication of books such as" The Limits to Growth", and the first UN Conference on Environment and Development, that was hold on 1972 in Stockholm. Sustainable development is a qualitative development and it addresses life qualities and aims to improve the quality of life for future generations [5].

Urban sustainable development focuses on the quality of life in urban areas so that citizens living continuity be coupled with social welfare and prevent damaging of urban environment sustainability.

The strength of the sustainable development theory is logical attention to relation between components of development that leads to development preservation and continuity. On the other hand, there are two different and conflicting ideas in relation with urban form and moving toward sustainability: compact city and urban dispersal. Relationship between urban density form and quality of life is common point in all supporting and opposing comments of urban consolidation.

Advocates of urban consolidation claim that it creates safer and more alive urban areas and it supports local jobs and services and urban social interactions and concept of "Compact city" can be useful to promote urban life quality by means of creating stirring, appropriate, and attractive spaces that are affordable in energy consumption and encouraging public transportation.

However, opponents of urban consolidation concept claim that horizontal expansion and low density city development model leads to expansion and distribution of terrific effects in a wider space and its effects absorption in environment and lower Pollution, then life quality in this model of development will be higher. So, this model becomes very important to achieve sustainable development goals, considering urban life quality, and satisfaction level of available quality limit. Several physical factors have role in moving toward sustainable city. Although, physical changes without economic and ecological developments will not lead to cities sustainability.

Since construction density is not effective on all aspects of human interests and urban life quality, in reviewing of related literature only those indicators of urban life qualities are emphasized that will change by changes of urban density types in general and building density in particular. Literature of sustainable city has so many things to present in line with preservation and promotion of locative and non-locative qualities. Sustainable city preserve and promote citizens welfare in the long term and medium term, which results in the highest quality of human life.

Since nineteenth century, the balance between man and nature has been eliminated by technology rapid progress and consequently increasing of urbanization process. Nowadays, sometimes 75% of cities areas dominate by automobile for communication networks, garages, parking space, etc. Air pollution and noise due to industries and motor vehicle concentration, unlimited horizontal and vertical development of cities, considerable amount of waste production, emerging of greenhouse effects and heat islands are only a part of general results of these changes. In these urban concentrated centers, life quality decreases remarkably, so that resulted circumstances threat life of human and living creatures. Accordingly, urban planning and design has become so complicated because of sensitive and determinative role to rebuild such balance and they need creative new tools and methods [2].

Among different urban forms associated with urban density, majority of "compact city" theories focused on coherence between form of cities and quality of life. It claimed that urban compression creates safer and more alive urban areas. This tendency towards life quality is observable in contemporary movements towards modern and traditional and urban-village forms designing as dominated trend. "Compact city" idea can be useful to promote urban life quality by means of creating stirring, appropriate, and attractive spaces that are affordable in energy consumption and encouraging public transportation. But there are opponents against compact city idea in order to support of "expanded suburb" idea that have been introduced mainly by American and Australian.

Many studies have been conducted about coherence between environmental quality and urban density form. Burton compared 12 following indicators in England cities with different density by a statistical study:

- Access to facilities
- Access to green space
- Job accessibility
- Public transportation

- Opportunities for walking and cycling
- domestic living space
- health - general, mental and respiratory
- Crime
- Levels of social segregation
- Job opportunities
- Affordable housing
- Wealth

Williams studied exacerbation effects of use over a period of ten years in three areas of economy, environment, and quality of life with three specific indicators of private space amount, traffic impacts such as air pollution, noise and lack of space for cycling and walking, and potential bad effects of exacerbation use (compression) on neighbourhoods, such as noise, destruction and pollutions.

Chapman after study of settlements and man-made environment development and their accordance with environmental conditions in "Creating Neighbourhoods and Places in the Built Environment", checked these places quality, and also considered construction of people-friendly places. He emphasized on the following qualities in discussion of relationship between quality diversity and comfort level:

- Townscape and street
- Private spaces and Privatization
- Identity and Security
- Sense of security in the public domain
- Access to services
- Safety
- Public and private transportation

Aminzadeh uses following criteria to study tower construction effects in neighbourhood of Elahieh neighbourhood in Tehran:

- Effect on the environment performance (disturbances such as lack of privacy, etc).
- Bioclimatic effects such as wind and shading behavior model changes
- Pollutions (including noise pollution, air pollution, pollution from improper disposal of garbage and sewage)
- Visual impact in terms of height, shape and adaptation to environment

Opinions and experiences related to urban life qualities in different urban density represent different results and analysis. A review of literature related to issue in a general pluralisation, used indicators in these studies could be categorized in six groups:

- Social
- Physical
- Incompatibilities (mental and physical health)
- Accessibilities (passengers and pedestrians)
- Municipal services and facilities
- Climate

## Conceptual framework and research methodology

Object of this research is application oriented and it is based on recognition and level of effective local mechanisms and components on Rasht parking problem modification along with construction density increasing policies of this city. Study area in this city is Golsar neighborhood. Factor analysis method has been applied to understand the relation of density increasing phenomenon and parking problems exacerbation as well as its relation with construction density amount and its determinants that is floor area ratio and number of floor.

Factor analysis is a statistical method that is widely used in various sciences. Factor analysis is a combination of several statistical techniques that aim to simplify complex of complicated data. The main objective of factor analysis, if possible, is explanation of covariance interface between many of variables based on several invisible random quantities that are called "factors". Factor model is considered seriously regarded following discussion:

Suppose that variables can be classified by their correlation, i.e., all variables of a particular group are highly correlated among themselves but have relatively low correlations with other variables. It can be assumed that each group of variables shows a considered combination or factor that indicates observed correlations [8].

In order to measure variables in this research, at first required qualitative and quantitative information will be collected by questionnaire or available statistical data and status quo will be examined and its processes and mechanisms will be discussed after an analytical process. In addition, data analysis has been performed by SPSS and GIS software's.

## Rasht environmental features

The location and environment extent of cities has the greatest impact in formation of its future development. Therefore, plain environments have particular potential for urban development in comparison with mountainous environments. Rasht is located in a plain environment and its main part is formed between two rivers. The formation of the context is highly influenced by its environment. Low slope, slope orientation towards the sea, and fenny climate in north are affected by natural environment of the city. General slope of the city is in two directions of south to north, according to position of highlands in south and shore in north, and also south-east to north-west. The height difference between inner surfaces of city is very low and city status is flat and smooth. Generally, it is located on a slope between 0 to 2 percent. Since Rasht it is located in the alluvial plain, it has loose soil with little resistance. This phenomenon is exacerbated especially due to groundwater high levels. Rasht soil is mainly made of clay and sand. Generally, soil resistance of central region (older soils) is more than

other regions, but northern and eastern boundaries of the city that are located on younger sediments have less resistance. Loose and low resistance soil requires its strategies for soil strengthening during building construction. Rasht proximity to conterminous lines due to earthquake in Lahijan and Talesh fault, its location on seismic zone with high risk, and regarding to earthquake that occurred in this area it is necessary to pay special attention to the following points:

- Loose and non- resistance soil
- Groundwater high levels

The results of seismic analysis of Rasht new master plan provider consultant shown that alluvial layer have high resonance period and role of surface layers is more than other layers. Resonance coefficients increase by moving upward of period. These phenomena become more intense mainly in younger sediments. So in older areas of Rasht such as center and southwest, resonance coefficients are in minimum but in northern districts and new districts that have younger soil, earthquake risk is also higher. Therefore, in construction especially in construction of high buildings, certain characteristics must also be considered.

Regarding to mentioned reasons, master plan of "action criterion" as well as "previous plan" did not recommend basement floor for normal buildings, and it is subject to specific cases with particular conditions. This makes parking space problem solution harder and more complicated in Rasht and even other northern cities with similar climates in compression with cities in arid areas. In addition to problem of soil resistance and high-level of groundwater that make difficult to construct underground, flatness of urban lands cancels opportunity of parking construction by using of building blocks level difference.

## Social and cultural characteristics of Rasht

Although Rasht has been recently listed as metropolis in terms of official chart and governance and it is hoped that not only results in creation of more modern and more progressive landscape, but also leads to city increasing progress and emerging of Rasht potentials with its unique features in province and country. But it is obvious that Rasht has not caught yet by disasters of metropolitans like Tehran in terms of social and cultural relationships and interactions within the community and it is among middle ones. Although Rasht locative advantages have caused of migration at the provincial and often out-of-province level, but Rasht has relatively good ethnical and cultural homogeneity. This issue as well as specific ethical and cultural features of peoples of Rasht and this region have kept social interactions in a relatively good level. Therefore, joint space or half-public - half-private area in buildings have a more different concept to these people and despite increasing of apartment living, these interactions facilitate some problems of cumulative life in apartments.

## Golsar neighborhood features

Golsar neighborhood is located in a triangular district with an area about 608 acres in Northwest of Rasht. Its three edges are as follows: Zarjub River in western edge, Shahid Ansari Boulevard along with Rasht-Anzali Road in eastern edge, and Rasht airport in north. There were two main reasons for choosing this location:

- Since city slope is from south to north, height level reduces by moving towards north of the city, where north of the city is 10 to 13 meters below sea level (yet it is 15 meters above sea level). Therefore, level of groundwater is between 0.5 to 1 meters upper than south of the city. Groundwater level in this region is between 0.5 to 2 meters from ground surface. Water high-level make this area more capable to agriculture and decreasing of soil resistance creates many problems for construction. In level determination that performed by Iran Amayesh consultant engineers to identify Rasht development direction, Northwest areas (that Golsar neighborhood is located in this area) include low lands with gentle slope (1 to 2 %) which are suitable for farming.
- General tendency of people and mass constructors to this area: In 1350's this neighborhood was built for wealthy peoples and nowadays in addition to its expansion to around villages it is still popular among residents. This popularity has attracted mass constructors' attention to this neighborhood that resulted in numerous constructions in a short time. So that, Golsar neighborhood population grew increasingly. While Golsar neighborhood compression and buildings height increase over past 10 years in comparison with other parts of the city is visually recognizable for Rasht residents and especially Golsar neighborhood residents, statistics also confirms this compression. While total population of Rasht multiplied approximately 1.9 times since old master plan to new master plan, Golsar neighborhood population has multiplied approximately 2.5 times. While previous approved detailed plan had considered Golsar neighborhood with low building density and majority of buildings were in villa form with 1 to 2 floors according to 1375 statistics, in present this region has high density and buildings have 4 to 6 floors.

## Evaluation of research of variables and factors extraction

A questionnaire survey method used to evaluate qualitative variables. Questionnaire forms presented directly to residents of building and completed in place by residents demand or in another time. These buildings have been divided randomly by GIS software in term of three existing residential patterns; villas, apartments, and residential

complexes. Sample size number was 96 if (ρ) be equal to 0.5. It should be noted that N in formula represents constructed lots in Golsar neighborhood and it is equal to 14,000. This relation is calculated based on α= 5%. Questioning results inserted completely by 2 software of SPSS and GIS and map and statistical outputs, that will present in continue; have been provided by using of these 2 software capabilities.

In provided questionnaire, research variables questioned according to table 1 by converting to one or several understandable question for non-professional peoples (totally 22 questions), that in fact are measures to evaluate residential qualities related to building density. Research quantitative variables, that are related to building density component, have been extracted from information layers of Rasht detailed project consultant engineering and filling the provided check list during questioning of households.

Generally, performing steps of factor analysis is carried out as follows:

- Significant commonalities: First, the relationship between individual variables is studied, that have been selected to test spatial and environmental qualities as well as all variable with the phenomenon of spatial quality. Communalities Matrix shows common points of selected variables in explaining of phenomenon and KMO test shows communication of total data with phenomenon. Results of these 2 tests show that all variables, including parking variable, have role in determination of transformative residential qualities with building density.
- Determination and extraction of factors: Since factor analysis nature is essentially a reciprocating method, acceptable results can be obtained with more than one "run". In "run1", necessary and sufficient condition for factors extraction, Eigen values are considered greater than 1. With this prerequisite 11 factors are extracted. Column of cumulative percentage shows that first 8 factors explain 60% and theoretically this amount is enough [5]. So in next "run" with prerequisite of 8 for factors number, a factor analysis will be done again

After deleting all variables with dependence under 0.35 of factors (Table 1), it can be seen in above table that there is not any deleted row and all variables are involved in factors explanatory. First, second, and third factors that have the most share in explanation of this phenomenon and third number (Table 2) has both parking and building density factors that are used research theories analysis. Third factor provides environmental comfort phenomenon, that has an 8 percent share on residential qualities related to building density increasing and confirms relation of occupation level with total land area and parking.

Study of Communalities matrix results of variables involved in third factor emphasizes that

- A strong and inverse relationship between lot area and floor area ratio, indicates that in smaller pieces, proportion of built area increases.
- A strong and inverse relationship between percentage of floor area and parking confirming parking problems increasing in lots with more floor area ratio.

**Third factor spatial interpretation**

Although spatial explanation of this factor does not present specific zoning in Golsar neighborhood district, but determines 5 specified spots with the most score in terms of this factor that all are related to residential complexes with several blocks and high densities and relatively low FAR (Floor Area Ratio) Two larger and clearer spots are related to Golha neighborhood in Namaz Boulevard and Cactus and Kadus neighborhood in Somayeh boulevard.

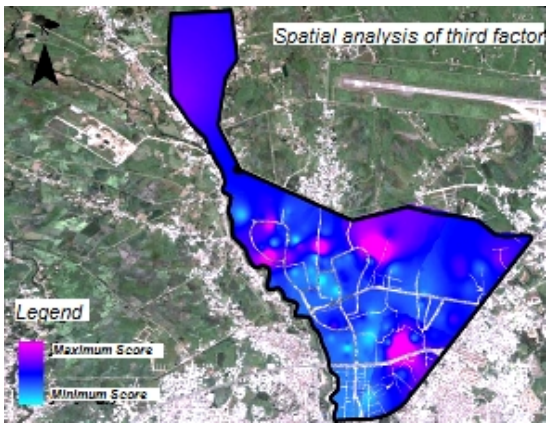


Figure 1 : Spatial Analysis of third factor

**CONCLUSION**

Building density increasing as a solution to accommodate growing population and prevent horizontal expansion of the city, especially in a city like Rasht with high-potential agricultural land, is an inevitable reality. On the other hand, problems and consequences of this density increase in a developing city like Rasht is other side of the story. In line with objectives of sustainable development not only city development consideration but also reduction consequences due to development are preferred and important. Parking space providing regarding to underground construction impossibility because of environmental specific features is one of serious problems of construction in Rasht. Regarding to statistical and spatial analysis of this research, residential complexes construction with high density, lower FAR and more floors in form of separate blocks with common area instead of available individual apartments could be a proper solution to modify this problem. In addition, social and cultural situation of Rasht could present other local solutions as noticed, because Rasht has been recently listed as metropolis in terms of official chart and governance but it is obvious that Rasht included

in middle cities in terms of social and cultural relations and interactions within society and it has relatively good ethnical and cultural homogeneity.

Table 1: final extracted factors of factor analysis

| Variables | Factor | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Area | | | 0.9 | | | | | |
| Mass Area (aristocratic) | | | 0.93 | | | | | |
| Occupancy levels | | -0.44 | -0.7 | | | | | |
| Floors | 0.94 | | | | | | | |
| A plate | 0.75 | | | | | | | |
| Number of Units | 0.84 | | | | | | | |
| Unit area | | 0.55 | | 0.58 | | | | |
| Floor of questioned residential unit | 0.79 | | | | | | | |
| Geographical direction of questioned unit | | | | | | | 0.81 | |
| Number of rooms | | 0.45 | | 0.58 | | | | |
| Amount of natural light | | 0.69 | | | | | | |
| Need for supplementary heating | | -0.24 | | | | 0.39 | | 0.48 |
| Natural ventilation rate | | 0.71 | | | | | | |
| Natural coolness rate | | 0.74 | | | | | | |
| Tangible moisture content | 0.36 | 0.07 | | 0.33 | | 0.66 | | |
| Vision and perspective | | 0.62 | | | | 0.37 | | |
| Visual qualities | | 0.67 | | | | | | |
| Social class | | | | 0.46 | | | | 0.47 |
| Social interaction | | | | -0.63 | | | | |
| Social security | 0.51 | | | | 0.49 | | | |
| Nuisance noise | -0.32 | | | | | 0.58 | | |
| Goo | -0.22 | | | | 0.6 | | | |
| Annoying traffic | -0.48 | | | -0.35 | | | | |
| Residence backup services | | | | | 0.5 | | | |
| Roadway access | | | | 0.57 | | | | |
| Waste disposal | | | | | | | | 0.73 |
| Sewage disposal | | | | | 0.74 | | | |
| Satisfaction from parking | | 0.43 | 0.44 | | | | | |
| Privacy | | | 0.44 | | | | 0.58 | |
| Vision on | | | | | | | 0.41 | |
| Building strength | -0.36 | | | | | 0.06 | | 0.44 |
| Factor change Percent | 15 | 11 | 8 | 7 | 6 | 6 | 6 | 5 |
| Cumulative change percent | 15 | 26 | 35 | 42 | 47 | 53 | 58 | 63 |

Table 2: Communalities matrix of third factors variables

| | Piece area | Occupied area | Occupation area percentage | parking |
|---|---|---|---|---|
| Piece area | 1 | 0.98 | -0.5 | 0.16 |
| Occupied area | 0.98 | 1 | -0.55 | 0.2 |
| Occupation area percentage | -0.5 | -0.55 | 1 | -0.49 |
| parking | 0.16 | 0.2 | -0.49 | 1 |

This issue and also specific ethnic and cultural features of Rasht and north territory and a fairly good level of social interaction, present different definition of joint space that facilitates some problems of apartment living and using of joint space, for example agreement between the owners to use dependence parking in apartments. Moreover, it seems that due to average level of households' income and less need of people to personal vehicle to get to work and elsewhere because of relatively short distances and milder climate and less pollution, car ownership rate of households is lower than metropolitan like Tehran. So in addition to complex construction that is optimum state in this condition, all these cases add together to reduce parking rate for residential units to provide more materialization

and less construction violations regarding to specific spatial, local, and cultural features.

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