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Assess Degree of Compaction and the Extent of Urban Development Perspective of Sustainable Development (Case Study: Yazd Province Cities)

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Abstract— with the rapid increase in world population and its concentration in cities, suburbs and expanding Wide Patent cities expanded and high rates of urban planning crisis in most parts of the world took to the wide dimension. Paradigm to achieve sustainable urban development and social justice and space were considered. The same paper is intended to descriptive and analytical method using dense urban issues, how compact urban development and broad representation to the city of Yazd. The investigations carried out during the years 1385-1345, about 19 times the area of Yazd city and its population has increased 5 times. During the same years, the gross population density of 131.3 people per hectare to 34.5 cases has decreased. Sharp reduction in the gross population density and the considerable distance net population density (154.6) represent the extent of the city and too many empty spaces and remain inactive levels of the urban area of Yazd city. Inconsistency with population growth and caused the land area for 22 years with the population growth rate to absorb 2.5 percent in the metropolitan area population is available. The life of the variation in the distribution of urban services and improved access to facilities is life for city residents and caused construction costs in upstream energy and waste. Urban sustainable development and social justice must be questioned.

Index Terms— density net, gross density, compact city, city wide, sustainable development, the city of Yazd.

1 Introduction

DEVELOPING countries cause many problems such as uncontrolled development of cities (Pugh,1995;384). The uncontrolled development problems of the cities and lack of plan can result in inefficient urban policy making issues and false urban development plans (Lier,1994 ;5). Effective urban development and plans (Lier,1994;5). Effective urban development and organization the urban areas are important factors for scientists and experts in urban planning. By introduction sustainable urban development, the vulnerability of the spread- out city in which has many problems because of high cost transportation and infrastructure and housing, has become clear than earlier (Gusdorf & Halleftte,2007;4826).

Condensation and compression of cities was considered as a solution for urban problems raised from spread out of urban development (Gordon et al 1989;140-143).

Infarct 'compact city' idea was a reasonable reaction to concerns about spread-out of urban development (Tory, 1996; 68).

Spread out of urban development cause increasing the energy consumption and damaging of agriculture land while compact urban development that has high density of population, reduces energy consumption and minimizes pollution (Aldous,1992;27).

In spread-out urban development, many of urban regions remaining empty and city hasn't an ideal configuration and use of urban transportation facilities increases (wsp & ns, 2004; 23) while compact city is base on ecologic planning and in accordance with geographic equality and social justice.

The category of urban density is one of the assurance components for compact urban development or spread-out urban development. This category has become to most important elements in urban development policy in iran and it has emphasized in different framework of planning recently (ghorbani, 2004;113).

The city of yazd that its origin return to pre-Islamic period, has experience uncontrolled and nonorganic growth at about four decades (1966-2006). The areas of urban zone has become 19 Equal than earlier while at the same Equal its population become 5 Equal, lack of harmony and increasing area more than population cause spreading the urban inactive level. There is 5872/79 hectare of urban inactive level that forms about 43/78 percent of urban areas. This value of urban inactive level resulted to increase gross percaptia of ground un expectedly and reached to number 334 m^2 and the population density reduced to 34/5 persons/hectare (taghvaie and saraei, 2006; 145). According to this condition, study of urban density and how distribution of population in urban regions in yazd and clarify factors affect to inefficiency urban development and negative effect of spread out city are necessary. So, this paper is studding urban density during (1966-2006) and analysis effects of density on urban development in yazd for clarify effects and dimension of inappropriate distribution of urban density on the urban problems creation and resolving them.

1-1- Research Questions

Is there a relation between effects of density and urban development in city of yazd?

2-1- Research Hypothesis

It seems there is a significant relation between effects of densi-

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ty and how to urban development in city of yazd.

2 METODOLOGY

The purpose of this study is survey of how urban development in city of yazd base on the urban density index. According to the nature of mentioned case and components the dominant of approach to the study is descriptive-analytical. Information has been collected from yazd housing and urban development organization and urban master plan. Then, density and spread-out of yazd have been studied and analyzed by underlying urban density as a master component for identification how the urban development is and using statistical models, Lorenz curve, holdern method and etc.

1-2- The study Area:

Yazd province with area about129214 km2 (7/94 percent of total area of Iran) is third most widen province in country. Base on the last political division in 2011 have 11 cities, 24 town, 20 sections and 51 rural district (statistical center of Iran, 2011). According to statistical data in 2011, yazd with 486152 population has 7 Equal population than meybod, second largest city in province.

The highest population density between cities of province belong to city of yazd with 32/7 persons/km^2 and the lowest one belong to nir with 1/6 persons/km^2 (table 1, fig 1).

TABLE 1
STRUCTURAL DIVISIONS OF CITIES IN YAZD PROVINCE 2011

Cities	Population	Area(He)	Net Density
Abarkouh	23986	2856	8/4
Ashkezar	15663	2504	6/3
Ardekan	56776	3997	14/2
Ahmadabad	5019	1168	4/3
Bafgh	33882	2343	14/5
Bafrueyh	6486	1152	5/6
Bahabad	7652	1367	5/6
Taft	15717	2487	6/3
Hamidiya	37428	1216	30/8
Khzrabad	581	311	1/9
Dyhuk	3346	1022	3/3
Zarch	10753	973	11/1
Shahedyh	16571	1845	9
Tabas	35150	2602	13/5
Ashghabad	4623	577	8
Aghda	1809	637	2/8
Mehriz	28483	3590	7/9
Meybod	66907	5906	11/3
Mehrdasht	7390	1089	6/8
Marvast	8865	576	15/4
Nir	1620	1035	1/6
Nodoushan	2332	452	5/2
Herat	12392	1033	12
Yazd	486152	14877	32/7

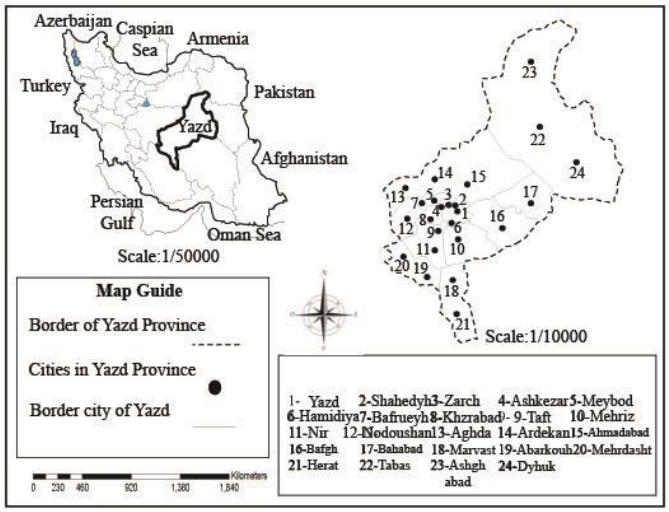


Fig 1: Political - Office Divisions of Yazd Province cities
Source: Statistical Center of Iran, 2011

3 RESEARCH FINDINGS

1-3- Time Analysis of urban density in city of Yazd:

The city of Yazd like other cities in Iran has experienced inorganic development scenario after land reform, that is Inharmonious and uncoordinated physical development has been preferred to physical development (pour ahmad & shamaei, 2001; 10). It resulted in unless more than 1300 hectare of land in urban zone (urban land organization of Yazd province, 2001). Base on the statistical data in 1966, city of Yazd has 710 hectare area and its population was about 131/3 persons/hectare during 1966-2006, urban physical development has more trend of growth than population and urban density reduced from 131/3 persons/hectare to 34/5 persons/hectare in which indicates continues of horizontal development growth and uncontrolled development of city by high speed trend (table 2).

TABLE 2
POPULATION TRANSFORMATION, BUILT SURFACES AND URBAN DENSI-TY IN YAZD CITY 2006-1966

year	Area(He)	population to people	Percent of Area Changes	Percent of population Changes	population density
1966	710	93241	-	-	131/3
1973	924	120000	30/1	28/7	129/8
1976	1157	135925	25/2	13/3	117/5
1983	2665	206384	130	51/8	77/4
1986	3400	230483	27/6	11/7	67/8
1996	8550	326776	51/5	41/8	38/2
2001	10708	373054	25/2	14/2	34/8
2002	11000	380103	1/89	1/8	34/5
2006	13388/7	461743	2/71	21/5	34/5

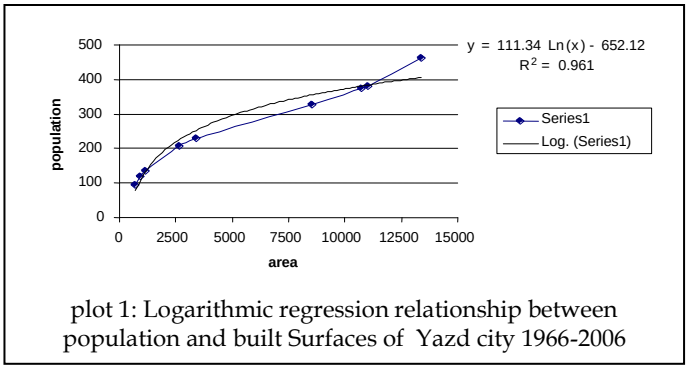
Source: Master Plan for Yazd city and authors calculaions

Table (2) indicates decline trend of population density in city of Yazd. During 1966-2006, annual growth rate of Yazd areas was about 8/2 percent/year so that this number for population at same time was about 4/1 percent/year. This means that population growth rate does not display harmony with area growth rate and area has more two time growth than population in which this result raises horizontal and uncontrolled development in city of Yazd. The index of area variations has increased from 25/2 in 1976 to 130 in 1983. This index to population in these years has increased from 13/3 to 51/8. This case indicates increase of population and physical development for city during several years after revolution have many population from war immigration have came into this city. Studying regression relation between increase of population and area of city indicate strong and significant correlation for them.

Regression relation between these factors follows from following logarithmic relation:

Equality $y = 111/34\ Ln(x) - 652/12$ $R^2 = 0/961$ in plot (1)

shows that area of city has more growth than population and also by increase of population, its density has reduced in which correlation coefficient between increasing the population and density during 1966-2006 was about –0/97. This indicates that she was reversal and negative correlation between two variables. This case is according to worldwide experiences. Because by increasing the city area, it creates new needs and new spaces (ghorbani, 2005; 125). But growing the urban areas and spaces in city of Yazd was more rapid than population in which this case raised from uncontrolled development in city of Yazd.



plot 1: Logarithmic regression relationship between population and built Surfaces of Yazd city 1966-2006

Considerable interval between urban not density and urban gross density is an important point in analysis of Yazd urban densities. In 2006, gross density was 34/5 percent / hectare and net density was 154/6 persons / hectare. This case conforms uncontrolled growth of Yazd. The interval 120/1 between gross and net density in hectare indicates that there is empty and non structured lands within urban zone.

2-3- Studying Centralization and Dispersion of Urban Density Using Statiscal Methods:

In studies of urban planning, having a quantities number of population is absolution necessary but it is not enough to reach purpose and it should be stabilized a relation between area and population then relation between pressure of population on the land and economical facilities are created (javan, 2001; 74-76). Furthermore, density is one of the most important elements in urban context in which are always considered by urban planners (ghorbani, 2004; 113). Reasonable relation between urban densities and urban area can result in optimum and equal distribution of resources and equality social, economical, cultural, physical, entertainment facilities and services between different regions in cities.

For study of how distribution of population and area are, statistical quartet methods and Lorenz curve have been used.

a- Quartet Distribution Method

In quartet method that urban density is divided to four sections and value of each section are determined (mahdavi, 1998; 66). First, areas density were arranged from lowest to highest values base on density and divided to four equal divisions based on number of areas. Based on content of table 2, about 75/3 percent of city population have be longed to 35/4 percent of city area will in regions with high density in which include full context of city only have 17/9 percent of city area. Only in moderate and high density, population with area has distributed uniformity. There are many populations in city center and old context and there are population dispersion in the new and countryside section of city (table 3).

TABLE 3
POPULATION DISTRIBUTION AND AREA OF YAZD CITY BASED ON STATISTI-CALLY QUARTERS

quarters	area	population	Percent of aera	Percent of population
Low density 1-17	4741/8	69982	35/4	15/3
Medium Density 17-28	3471	117947	25/9	25/5
High density 28-49	2784/3	117641	20/8	25/4
Very high density 49-76	2391/7	156183	17/9	33/8

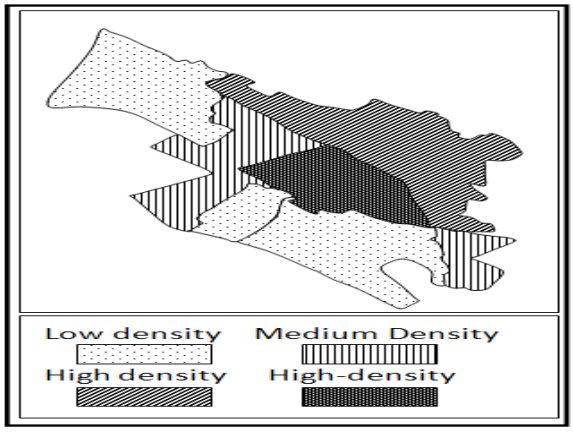


Fig 2: Distribution of population density Yazd city Based on Quartile statistical

B- Lorens Curve:

Lorens curve is one of Measurement methods of how population distribution is in areas of a city. To display population distribution and population acceptance in urban areas on the lorens curve, density percentage of the number of area is used on axis x and density percentage of population is used on axis y in which using this method, population distribution in urban regions have been studied.

The value of Gini factor was 0/26 that display there is a relative harmony between population distribution within urban regions in city of yazd. Mismatch value is about 0/26 . This mismatch occurs because there is not equality and there is not a proper relation between population growth and area (km^2)(table 4).

TABLE 4
DENSITY PERCENT OF POPULATION AND AREA IN YAZD CITY DISTRICTS 2006

Districts		Area			population		
		Amount	Percent	Accumulated Percent	Amount	Percent	Accumulated Percent
Region 1	District 1	1036	7/7	7/7	34109	7/4	7/4
	District 2	977	7/3	15	49491	10/7	18/1
Region 2	District	1380/4	10/3	25/3	101701	22	40/1
	District 2	945/7	7/1	32/4	39244	8/5	48/6
	District 3	861/5	6/4	38/8	28906	6/2	54/8
	District 4	1011/3	7/5	46/34	54482	11/8	66/6
Region 3	District 1	1749/7	13/1	59/4	49912	10/8	77/4
	District 2	1694/8	12/6	72	363666	7/9	85/3
	District 3	1025	7/6	79/6	12806	2/7	88
Separate Districts	Shahedyh	2022	15/2	94/8	20810	4/6	92/6
	hamidiya	685/3	5/3	100	33926	7/4	100

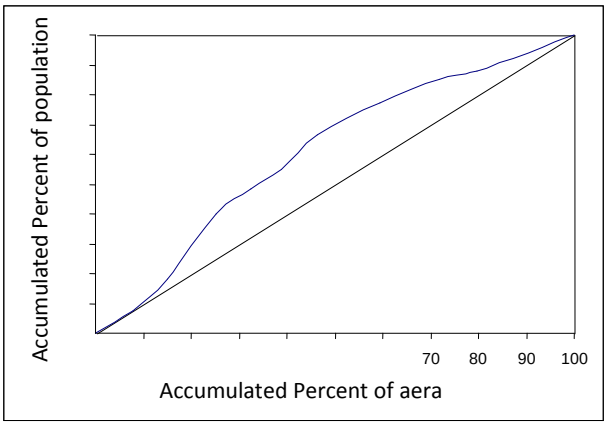


Chart 2: Lorenz curve of area and population cumulative percent in Yazd city 2006

City of Yazd:

Three indexes include density gradient index, full context urban zone ratio and holdren methods have been used for analysis of urban development. In city of yazd and urban span and compression.

A- Analysis Density Gradient

Density gradient is a Criterion for measuring the suburbanization in cities. Gradient equality sets base on two factors include distance from city center and population density that mentioned method at the first time was used by Clark in 1971. Ghorbani was used this method for city of tabriz (ghorbani, 2005; 126). Study of density gradient and its variations in city of yazd indicates extreme reduction of gradient from center to suburban, from center until radius 2500 m, urban density is about 60 persons/hectare that at radius 3400 m reaches to 54 percent / hectare and at radius 4300 m it is 38 persons / hectare and finally, at radius 13000 m this value reaches 5 persons/hectare (Chart 3).

City center has high population density, because commercial-services activities are done in this region, old context and disadvantage family with high number of children exist within this region of city, reducing density from center to suburb is caused by many empty places within city and widespread development of city.

Different variation of density gradient in yazd, from center to north and south occurs with extreme reducing of density. There is a relative reducing of density from center of city to west and east direction. International and communication road in which has caused linear development of yazd toward south and north direction and joining villages to city of yazd are most reasons for extreme reducing of density from center to north and south direction.

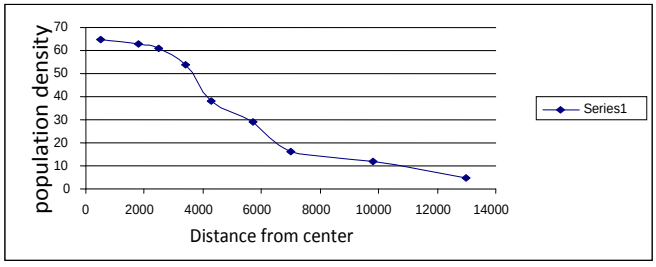


Chart 3: Density gradient curve in Yazd city 2006

B- Area (km2) of City Zone Ratio

This is one of method to clarify the city development, urban context zone with centrality of Shahid Beheshti Squar (C.B.D) and location of breaking the density gradient curve was computed. Then using dividing urban full context to city zone, amount of compression and span of city was determined.

Are of urban full context is 155 hectare and total area of city zone is 13388/8 hectare that mentioned coefficient for city of yazd is 0/12 . This number is equal with number of 0/345 for city of tabriz that computed by ghorbani (2005). Compare numbers indicates that city of yazd has a considerable span in urban development.

C- Holdren Method:

The holdren method is one of methods for clarification of uncontrolled urban growth. Jhon holdren used this method for determine of the horizontal urban growth and population growth. Using this method, one can clarify how much of city growth rises from population growth and how much rises from uncontrolled urban development (Hekmatnia & Mousavi, 2006, 131-133).

Results of table 5 show that during 1966-1976, 77 percent physical development comes from population growth and 23 percent comes from horizontal and uncontrolled development. This number during 1976-1986, 49 percent for population growth and 51 percent for horizontal development was computed. During this period, horizontal development of city relative to earlier period increases about 28 percent immigration of rural population into city and forming ecological segregation in city of yazd, in which lead to suburban regions, are reasons for this case.

During 1986-1996, uncontrolled urban development reached to 62 percent, during 1996-2006, because of urban master plan operation and control of development of city, uncontrolled urban development has been reduced extremely and reached to 33 percent. Totally, during 1966-2006, about 54 percent of yazd growth rises from population growth and about 46 percent of growth rises from urban widespread growth. As shown by the other methods, the city of yazd is grown widely. Proposed density in master plan has been estimated about 60 persons / hectare. Assuming this density, potential population with current area will be about 803326 persons. About 2/5 percent should be considered for annual population growth if population growth the city of yazd facing extreme immigration, in that case, exponential population growth (zanjani, 1999, 256) Shows that city of yazd has enough land for attract population about 22 years, with current extent until become a compact and acceptable city.

TABLE 5

CALCULATION OF PHYSICAL GROWTH YAZD CITY USING HOLDERN METHOD

Period	growth Due to population (percent)	growth Due to widespread (percent)
1966- 1976	77	23
1976- 1986	49	51
1986- 1996	38	62
1996- 2006	77	33
1966- 2006	54	46

3- Discussion and Conclusion:

While rapid increasing of population is occurred For cities, especially in development countries, urban sustainable development is necessary to encounter with disasters that threats human societies in future (Auclair, 1997; 289), kind of urban development, sustainable, that considers current residences of city without destroying of future generation (wced, 1987; 43) and reduces threats that posed by the Futile use of nonrenewable resources (Burgess, 2000; 10). Compact city and avoiding of uncontrolled development is one approach of urban development that urban planners have considered to reduce waste of energy resources and destroy of agricultural land during recent decades.

As results of study shows, using urban density for explanation urban development, can be proper criteria.

Analysis of urban density in yazd indicates that city of yazd has experienced an Inharmonious development after lands reform based on statistical data, number of density 131/3 persons. In 1996 has reduced to 34/5 persons in 2006.

Extreme reducing of density in city of yazd raises from suburbanization and uncontrolled development widespread development of yazd has been resulted to non equality distribution of urban services between different regions and has threaded social justice and social space, because wide spread urban development has need to car for access of services that middle – class and low income citizens can't buy automobile so lost many of their income for transportation cost. On the other hand, higher cost for infrastructures and using private cars by rich citizens, increased environment pollution so that space sustainability and justice lost its position in society. Different methods such as quartet, density gradient, urban full context to area of city ratio and holdren equality method have been used to display more wide spread development of yazd. Results indicate this trend.

Quartet method validates mismatch between non-harmonious spatial distribution and population and index of area and population variations shows that area of city of yazd have been grown several time than population. Comparison between urban net density and gross density indicates considerable distance between them. So that their distance is about 120/1 persons/hectare. This case raises from many empty places in city zone that remainds as an inactive urban levels. This case has resulted to horizontal and wide spread development of yazd. The study of yazd development base on holdren method also indicates more spread-out of city. Results for this method during 1966-2006 show that only during period after 1986, because of urban master plan operation and land control policies and urban density, wide spread and suburbanization has been prevented. Nevertheless, using of exponential population growth method with assuming an annual

growth rate about 2/5 percent shows that the city of yazd don't need land to accumulate population for urban development during 22 years of future.
Thus, only by doing land control policies and urban development, the city of yazd about 22 years later will be change to a compact city, otherwise, not only it will not access a compact form but also its suburbanization will be more than before.

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