SPATIAL-PHYSICAL ANALYSIS OF THE URBAN SMART GROWTH INDICATORS (CASE STUDY: DISTRICTS OF RASHT)

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Abstract. Extensive changes in cities and their population has led to population and environmental crises. New strategies including the smart growth have been proposed to overcome this challenge. In fact, the smart growth strategy is an attempt to lead the cities toward sustainable and environmental approach. Principles and strategies of smart growth create effective solutions for improving transportation and urban land use. This research investigates the compatibility of the regions and districts of Rasht (A northern city in Iran) with the smart growth criteria in a case study using Shannon analytic model, Holdern Model, and TOPSIS multi-criteria decision making model. The results of the Holdern model analysis indicates a dispersed growth of Rasht and displays its sprawl. Shannon entropy coefficient confirms a horizontal and dispersed growth of the city in its four districts and demonstrates that district 2 has the highest population and building density. The results of TOPSIS multi-criteria decision making model and entropy weighing method present dispersed and unpleasant urban growth and show district 3 has the highest density and compatibility with the urban smart growth criteria, and district 4 has the lowest density and the maximum difference comparing to the urban smart growth criteria.

Key words: physical-spatial development, urban smart growth, sprawl, Rasht

1. Introduction

The rapid urban growth has bred various problems whose form has changed especially in recent decades. Dispersion of human settlements on earth and environmental problems have created hazards that have made parents worried of their children's destiny, in other words, the future generations'. They are concerned with the earth that no longer would be an appropriate place for the future generations to live on as a consequence of excessive and wasteful consumption of resources and pollution of the environment. Discussions around sustainability and consequently the smart growth were emerged following these considerations, and turned to one of the most prominent urban discussions.

This study tries to achieve these objectives:

- Identifying and determining effective metrics in smart development strategy of the city:
- Investigating the process of physical and spatial development of Rasht to monitor and control it
- Surveying the physical-spatial dispersion of Rasht

Many experts and theorists have studied in this field, hence there is a rich background for it.

Finding a suitable model for the development of a city in terms of physical, social, economic, and environmental dimensions and in accordance with the criteria and principles of the smart growth strategy needs the physical-spatial analysis of the urban areas, the examination of the present situation of the city in terms of social and economic features, and the analysis of environmental features. By collecting analytical information, the priority is given to urban areas based on the criteria of the smart growth strategy, which seeks to make important strides in reaching sustainable urban development goals and achieving the smart growth. This article endeavors to examine the indicators of the smart growth in spatial-physical development of Rasht, and investigates the extent of its urban growth compatibility with the indicators.

The comprehensive growth and the expansion of human societies is the ultimate goal of city development; reaching a balanced development necessitates a comprehensive recognition and understanding of the conditions and requirements of human societies and their needs (Rezvani, 2003).

The increasing phenomenon of urbanization has faced the future of the planet with urban prospects (Rennie Short, 2009) and the pattern of inappropriate consumption of natural resources has exacerbated the instability of cities (Sarrafi, 2000) leading in many physical, economic, social, and environmental problems, especially in developing countries (Pourahmad *et al.*, 2009). The widespread economic and technical developments after the Industrial Revolution caused sharp changes in the size of cities and population of their inhabitants. As this process continues, metropolitan cities are dealt with rampant dispersion, and consequently destruction of farms, forests, and natural resources (Ziyari *et al.*, 2009).

On the other hand, urban sprawl amplifies the traffic in cities and the shortage of public transport, and eventually increases private car use (Stephen, 2008). The issue of "urban dispersion" has been raised since the appearance of cars but it originally dates back to the expansion of housing after the Second World War when William White used the term urban dispersion for the first time in 1958 (Basudeb, 2010).

Developmental dispersion or in other words sprawl seems unplanned, uncontrolled, uncoordinated, lacks mixed landuse, and low density and linear, dispersed, and desultory growth are its features. It is mainly due to the transformation of economic bases of city, possibiity to interfer in land stock market, negligence in urban designing policies, and sudden decisions for urban development that sprawl occuers (Ismailpour, 2011).

Since the early 1970s, urban and transport planners have begun to promote the idea of "densely populated cities" to address the negative impacts of urban sprawl. Peter Calthorpe proposed the idea of urban village based on public transportation, pedestrians and bicycle lieu of private car, and then Andres Duany proposed changes in urban design rules to promote the community concept and reduce the use of private cars. As a result, the urban smart strategy of the "smart growth" appeared. This strategy is based on the theoretical foundations of the "Sustainable City" and "Ecological City" and integrates residential and occupational functions with the priorities of pedestrian access design (Ziyari, 2001). In its European-American origin, this pattern is a system-specific strategy with clear dimensions and methods, but in most developing countries, including Iran, it is often considered as a single dimension approach and is mainly viewed as purely economic (Pourmohammadi and Ghorbani, 2003).

3. Concept and methodology

3.1 Concepts of the smart growth

The smart growth provides a pattern through integrating economics, community and the environment, and a framework for informed decision-making through advocating economic and occupational development and the creation of a variety of choices including housing, trade and transportation, and the possibility of reaching a healthy neighborhood (Duany, 2003). Based on such initiatives, the smart growth is considered as efforts which are being made to promote more densely populated neighborhoods and to cope with sprawl (Song, 2005). The smart growth by emphasizing accessibility, claims compatibility with sustainability components (Bakhtiari and Rahmdel, 2014) and it is a strategy for integrating urban transport and urban land use by supporting intensive development and mixed landuse in urban regions that fights the vehice oriented urban development approach and sprawl (Frank *et al.*, 2006). Smart development consisting of a complex concept and a set of principles of land use and transportation is in contrast to the pattern of sprawl, and is based on the theory of sustainable urban development and advocacy of a compact city pattern (Howard *et al.*, 2004). In the smart growth approach, unlike functionalist urbanism of the "Athens Charter" which divided the cities into four distinct functional zones "activity, habitat, recreation, and communicative network" (Mahdizadeh, 2000); complex use, pedestrian access, and environmental protection are all emphasized. According to the American Planning Association (2009), mixed-use based development, meeting the needs of community residents, has an effective role in empowering urban areas in terms of vitality, sustainability, socialization, proper access, safety, social awareness, and efficiency of the infrastructures (APA[1] , 2009). Also, sustainable access is facilitated and financed by integrating land use planning and consequently "proximity" rather than "facilitating the cars" (Sarrafi, 2000). The strategy seeks to rebuild the cities and direct them toward a capable community with access to the desirable environment (Pourmohammadi and Ghorbani, 2003). Its purpose is to design good small open spaces and create "village-cities" as an attempt to recreate the atmosphere of the cities in the past (Weeks, 2011).

Table 1. Difference of the smart growth and dispersion strategies in city development (Litman, 2016)

Criterion	The smart growth	Sprawl
Density	Compressed development	Low density, scattered activities
Growth pattern	Texture development	Development around the city
User confusion	Mixed land use	Homogeneous land use (individual and single-use applications)
Scale	Human scale (buildings, blocks, and smaller roads)	Large scale (Large blocks and buildings and wide roads)
Public utilities and urban facilities	Local, smaller, compatible with pedestrian access	Regional, homogeneous, bigger, need access to cars
Urban transport	Providing different transportation methods and land use patterns	Automotive transportation
Access	Roads, sidewalks and fully-connected routes for guided motor and non-motorized travels	A hierarchical road network with countless rings and endless automobile axes with unrelated sidewalks and non-motorized travel restrictions.
Street design	Conformed to diverse activities (traffic volatility)	Design of streets to increase the speed and volume of motor traffic
Planning process	With plan	Without plan
Public spaces	Emphasis on public areas (sidewalks, parks, and public facilities)	Emphasis on private areas (yards, shopping malls, closed and guarded spaces)
Effects	Reducing additional costs, saving on public service costs, on consumer spending, keeping open spaces, creating communities with more liveliness	Increasing unused land, increasing the share of open spaces, reducing population density, disrupting urban areas and social segregation, low traffic, car dependency, large residential areas in farms and high environmental and social costs

Bullard sees the Smart Growth Movement as an attempt in urban management by creating healthy, habitable, and sustainable communities, and new urbanization; smart growth and sustainable development are all in the direction of urban management (Bullard, 2007).

The Smart Growth Model, an attempt to target the future growth and development of the city, is the city's physical re-shaping in order to achieve sustainable development goals with an emphasis on easy access (Saeidi Mofrad and Mofidi, 2015).

The International Association for Urban Management (ICMA[2]) has a comprehensive definition of the smart growth: "The smart growth strategy is an economic, social, and environmental development that provides a decision-making framework for communities to where and how grow"(Hevesi, 2004).

The smart growth, ultimately, with a vertical and dense development model, will promote quality of urban life, diversity of design, economic empowerment, environmental issues, public health, diversity of public transportation practices, and access rates to reduce the trips and therefore air pollution and energy consumption (Rahnama and Abbaszadeh, 2008).

Table 1 shows the criterion of smart growth and sprawl in comparison to each other.

Table 2. Effective factors on making smart cities (Khamar and Heidari, 2016)

	Effective factors	Effectiveness on smart development
1	Compression	Very high
2	Mixed use	High
3	Household Income	Very high
4	Type of transportation vehicle	High
5	Development type (horizontal / vertical)	Medium
6	Choice of living place	Medium
7	Attention to the historical pattern of the smart growth	Medium
8	Development Capacity	Very high
9	Reduction of public spending	Very high

Table 3. Principles of the smart growth strategy (The Smart Growth Network, 2001)

The main components of the city	Principles of the smart growth
Environmental	1. Utilizing the design of compact buildings and the dense development model 2.Strengthening and directing development toward the existing texture with the desired use of land within the city 3.Protecting open spaces, farms, natural beauty, and vulnerable environmental regions
Social	4.Creating a range of options and different housing practices and making it possible to choose different types of homes for different social groups 5. Creating walking places 6. Providing various modes of transportation (walking, cycling, public transportation, and private vehicles) 7. Creation of privileged and attractive communities with a strong sense of place (providing identity and value for neighborhoods) 8. Providing various modes of transportation (walking, cycling, public transportation, and private vehicles)
Economic and urban management	9.Making predictable, fair, and fruitful development decisions 10. Strengthening and encouraging community, authorities, and investors collaboration and participation in urban development

John Hopkins, a member of the American Institute of Ecology and Health, sets out the goals of the smart growth strategy as creating living communities, proximity to nature, sustainable protection of valuable lands, public transit, suburban and urban regeneration of old parts of city, scopes of city development, and long-term prospects for communities (Pafrey, 2017).

Responding to the urban dispersal phenomenon with increasing housing costs, high traffic congestion, and high costs for building public transportation infrastructure, the smart growth strategy aimed at balancing the needs of people with jobs and economic development (Peiser, 2001). Effective factors of making smart cities are shown in Table 2.

The smart growth strategy, with an emphasis on accessibility and concentration of community-centered activities, considers the main unit of the smart growth planning to be local communities or villages, and recommends that the most appropriate solution in urban transport is applying mixed usage patterns, minimizing negative and destructive effects on green space, and reducing travel by motor vehicles. The objective is the creation of a quality, legible, and specific place of living (Bochner, 2000).

Despite the controversy in the definitions of the smart growth as a tool-driven concept, there is a consensus on the ten principles of this template (Table 3) provided by the American Environmental Protection Agency (EPA). Any society that meets its specific climatic, economic, and social conditions can adapt to some of these principles (EPA, 2010). According to the Brookings Institution, through the application of three efficient methods of reducing public service costs by focusing on the existing infrastructure development, improving the economic condition, and creating a massive labor market with more healthy urban centers and fewer congestion, it is possible to boost local or regional economies and make financial savings with the help of the smart growth strategy (Humstone, 2004). The smart growth indicators (Table 4), with a focus on all social, economic, physical, environmental, and communicative aspects and with an emphasis on per capita use, often address the diversity of land use, access, and quality of the environment. Higher construction density, the ratio of mixed and public usage, pavements, green space, and space at the neighborhood level indicate that the neighborhood and region are smarter (Ferdowsi and Shokri Firoozjah, 2015). Smart neighborhoods are relatively self-sufficient and enjoy a combination of residential, commercial, and administrative dimensions combined with public facilities such as school, library and park as well as an appropriate design for walking, cycling, public safety, environmental protection, long-term investment, and efficient use of infrastructures (Karimi and Negin Taji, 2012).

The proper application of the smart growth strategy can result in a variety of economic, social, physical, and environmental benefits. [t can also lead to urban economic growth and public service cost reduction, such as water and wastewater, schools, and roads by supporting the increased production and lower costs. This approach has positive environmental impacts, such as improving water quality, protecting green and open space and sensitive ecological areas through reducing and not removing trips by private cars (Litman, 2005). McCann believes that more than 20% of household spendings is allocated to road transport in dispersed regions, while in concentrated societies it is less than 17%.

Table 4. Indicators and sub-indicators of the Smart Growth Approach (Rahnama and Abbaszadeh, 2008).

Indicator	Sub-Indicator
compression	Population
	Area
	Gross density
Access	Access to bike lines
	Access to bus stations
	Access to metro stations
	Access to special taxi lines
Environmental	Air pollution
	Noise
	Access to green space
	Sewage network coverage
	Waste production
	The worn out texture of the city

3.3. Research methodology

Sustainable and balanced urban development improves quality of life, provides easy and low cost transportation, reduces environmental pollution, and causes socio-economic stability. Due to the influence of various factors on the process of growth and development, controlling the extent and directions of urban development, especially in the field of urban management, is essential. On the other hand, due to the lack of a comprehensive long-term urban planning and the non-observance of the rules, principles, and criteria of physical development in the past, the development of Rasht is witnessing sprawl as a result of numerous issues and abnormalities. Therefore, controlling and organizing it will require an accurate identification and study of the physical development of the city.

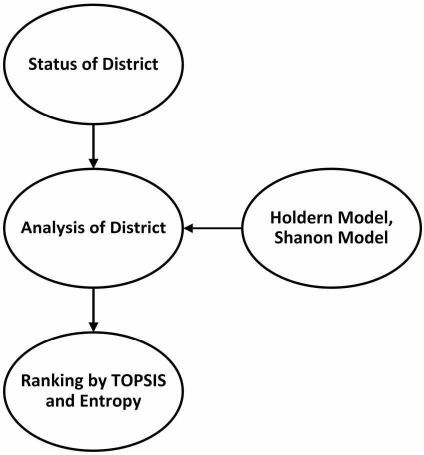

Fig. 1. Methodology of the study

Considering the objectives of this study, this research is descriptive-analytic based on library studies, documents, and applied surveys which follows the criteria and indicators of the smart growth in the socio-economic, environmental, and physical-spatial dimensions. So, the research will analyze the physical aspects of the city's districts after collecting required information from documents such as regional plans, city comprehensive plans, and census results. It uses statistical techniques to determine the level of urban districts and its degree of compatibility with the smart growth criteria.

4. Data and findings

According to the general population census in 2011, the metropolis of Rasht, as the political and administrative center of Guilan, the largest city of the northern Iran and the southern margin of the Caspian Sea, has a total population of 63,995 in the area of 10,461 hectares (Fig. 2).

The steps of this study are:
1. Determining the status of each district based on the research criteria
2. Analysis of the existing districts using different methods and models
3. Ranking of the city districts using analytical models such as TOPSIS[3] Multi-Criteria Ranking Model (Fig. 1).

Rasht, whose historical background dates back to 372 AH, was a village between two regions of Biepish and Biehpas of Guilan with the center of the cities of Fouman and Lahijan in the past, which found economic and political significance during the Safavid Shah Tahmasb era. After the fall of the Safavids and the occupation of Guilan by the Russians, the land was spread almost 15 miles to the south in the woods to provide land. This city was significantly expanded in Qajar period by building and developing Barbandan (Saghari Sazan) bazar markets and Saroubandan. After the Constitutional Revolution and during the Pahlavi period, with the construction of several streets and intersections in the city, the market was leaning toward the fringes of the streets and residential buildings were formed in densely populated neighborhoods of the city (Figure 3).

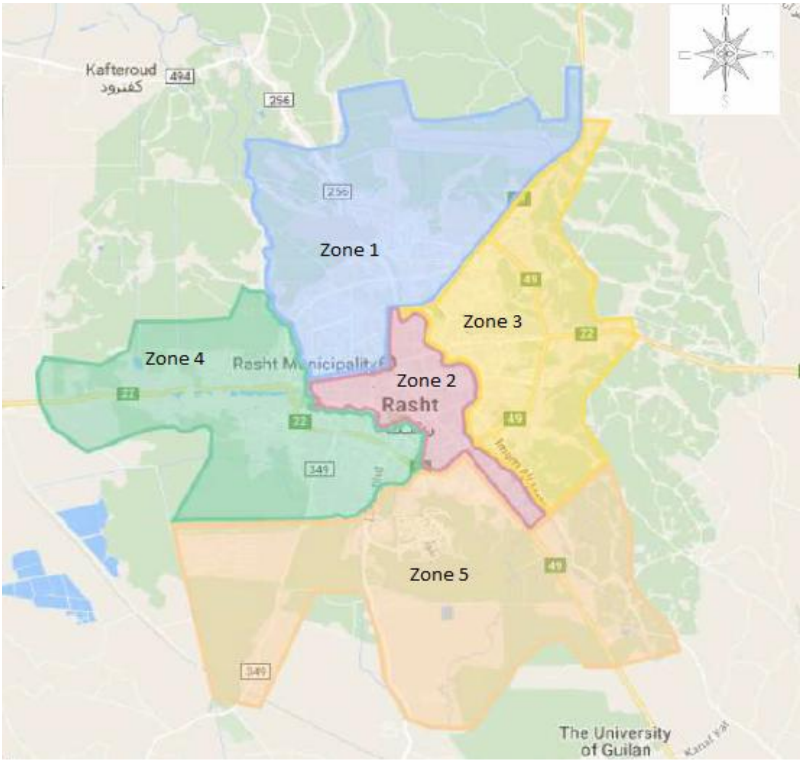

Fig. 2. Map of 5 areas of Rasht city (Consulting Engineers of Amayesh Iranian Report, 2013).

Table 5. Changes in population and area of Rasht during the years 1956-2011 (Consultant Engineers of Kavosh Report, 2007 and Censuses of the Iranian Statistical Center)

Year	Population (person)	Number of people added (people)	Annual population growth	Area (Hectare)
1956	109491	-	-	650
1966	143557	34066	2.78	950
1976	188957	45400	2.74	1190
1986	290063	101106	4.38	2994
1996	417748	127685	3.70	9250
2006	557366	139618	2.92	10240
2011	639951	82585	1.39	10461

Rasht expanded in 1948-1956, from the south, south-east and south-west, then until 1971 in west and northwest. After the Islamic revolution, growth of Rasht was towards north and northwest, and with the construction of the Rasht industrial town in this period and the foundation of the University of Guilan, it growed towards southeast. In fact, the city of Rasht was developed from 1978 to 1985 in the west to east and northeast direction, and since 1988 the development has continued toward southwest, northwest, and the road of Lakan (Consultant Engineers of Kavosh Report, 2007).

Table 7. Holdern model analysis results in estimating the dispersed ratio of Rasht in the period 1956-2011 (Consultant Engineers of Kavosh Report, 2007).

Period	Population at the beginning of the course (a)	Population at the end of the period (b)	Ln(a/b)	Gross per capita at the beginning of the period (c)	Gross per capita at the beginning of the period (d)	Ln(c/d)	The size of the city at the beginning of the period (e)	The size of the city at the end of the period (f)	Ln(e/f)	Share of population (Percent)	Sharp and horizontal growth share (percent)
1956-2011	109491	143557	0.2709	59.37	66.18	0.1086	650	950	0.3795	71	29
1966-1976	143557	188957	0.2748	66.18	62.98	-0.0495	950	1190	0.2252	122	-22
1976-1986	188957	290063	0.4286	62.98	103.22	0.4941	1190	2994	0.9227	46	54
1986-1996	290063	417748	0.3648	103.22	221.43	0.7632	2994	9250	1.1280	32	68
1996-2006	417748	557366	0.2883	221.43	183.72	-0.1867	9250	10240	0.1017	284	-184
2006-2011	557366	639951	0.1382	183.72	163.47	-0.1168	10240	10461	0.0214	647	-547
1956-2011	109491	639951	1.7655	59.37	163.47	1.0129	650	10461	2.7784	64	36

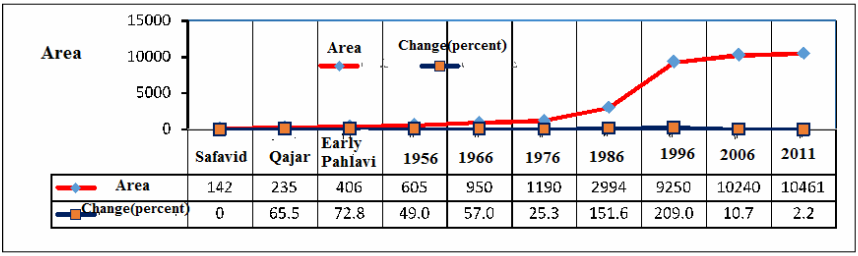

Fig. 3. The process of increasing the physical level of Rasht city by 2011 (Consultant Engineers of Kavosh Report, 2008).

The population of Rasht increased by 40.3 percent during the period of 1956-1996 (Table 5) and increased due to the migration and integration of surrounding villages in the city area much more than the natural growth rate.

The consequence of population growth is the physical development of the city, its expansion in peripheral lands, and the creation of many densed neighborhoods in terms of population density (Table 6).

5. Results and analysis

Various models are used to physically analyze the shape and form of the city and to plan for controlling its future physical development.

Among the models used in the urban sprawl studies and in determining the dispersion and density, are the Holdern Model, Shannon Entropy Model, and entropy coefficient. The multi-criteria TOPSIS model can also be used to determine the rank and the degree of adaptation of the city's multiple districts with the urban smart growth indicators.

5.1. Holdern model

One of the basic methods for determining the urban dispersal rate is to use the John Holdern's model to determine how much the city's growth is due to population growth and sprawl. In this method, the gross per capita, GDP, is used to analyze urban growth factors (Hekmat Nia and Mousavi, 2013).

The results show that the physical development of Rasht city from 1956 to 2011, was 64 percent due to population growth and 36 percent due to horizontal and scattered expansion resulting in reduced population density and gross per capita GDP growth. The most extensive physical development in Rasht was due to the unpredictable and dispersed growth factor in the first two decades after the revolution (1976-1996), and then the factor of population growth has had the greatest influence on the physical development of this city. Holdern' analysis demonstrates that the physical development of Rasht in its general range (except central regions and the core of the city) is dispersed and incomplete and does not have a high population density (Table 7).

5.2. Shannon entropy model

The Shannon entropy model is utilized to analyze the physical growth trend of city and its dispersion rate; the amount of entropy is calculated based on the total density of residential area in urban areas to total built-up area in the city and its value is from zero to Ln (n), which zero represents the development of compact physical development and Ln (n) reflects the sprawl of physical development; when the entropy value is greater than Ln (n), there has been an overwhelming growth (Hekmat Nia and Mousavi, 2013).

Table 8. Shannon entropy analysis of 1-2-3-4 districts of Rasht in 2011 (Source: Consulting Engineers of Amayesh Iranian Report, 2013).

District Rasht	Built area	Pi	LN(Pi)	Pi * Ln(Pi)
1	1062.0733	0.1172	-2.1439	-0.2513
2	5977.5540	0.6596	-0.4161	-0.2745
3	1011.2000	0.1116	-2.1930	-0.2447
4	1011.5300	0.1116	-2.1927	-0.2447
sum	9062.3573	H=1.0152	Ln(4)=1.3863	-1.0152

The value of entropy in Rasht in 2011 is equal to H = 1.0152 and its maximum value is 1.3863 (Table 8). The proximity of the entropy of the city to the maximum entropy value indicates the scattered growth of the city and declares the amount of dispersion over compaction. District 2 of Rasht has the densest texture (Table 9) and the best possible adaptation with the smart growth criteria and the other areas tend to sprawl index. Due to the lack of a detailed plan for District 5 of Rasht and the completely scattered texture of this district, the Holdren model was not applied.

Table 9. Area, population and gross density of districts 1 to 4 of Rasht in 2011 (Consulting Engineers of Amayesh Iranian Report, 2013).

District	Area (Hectare)	Population (person)	Gross density (Person per Hectare)	Density rate
1	2130	154092	77.8	4
2	662	87207	134	1
3	1535	126681	86	3
4	1962	189966	100	2

5.3. TOPSIS ranking model

The TOPSIS Ranking Model is one of the very best compensatory multi-criteria decision-making models to prioritize options by simulating an ideal answer to the aim of ranking, and selecting the preferred option that has a very low sensitivity to the type of weighting technique and the resulting response does not change profoundly. This model is based on the notion that the choice has the least difference with a positive ideal solution and more difference with the ideal negative solution (the worst possible). The TOPSIS scores range from zero to one, so the closer the TOPSIS indicator to one indicates the ideality of that rating (Hekmat Nia and Mousavi, 2013).

In order to rank the urban areas of Rasht based on the urban smart growth indicators (Table 10), the TOPSIS multi-criteria decision making model and the entropy weighing model have been used and the analysis of the physical structure of the four districts of Metropolis of Rasht in four general criteria of physical, socio-economic, communicative, and environmental networks has been performed.

In order to measure the sprawl rate of each district of the metropolis of Rasht, each of the spatial, socio-economic, communicative, and environmental indicators were calculated separately in the TOPSIS model, and finally, all indicators were combined with the urban smart growth indicators.

Investigating the results and the four districts of the metropolis of Rasht in the TOPSIS model regarding physical and land use criteria, district 3 with a TOPSIS score of 0.7878 was ranked one and had the highest compression and adaptation to the smart growth criteria, district 1 with a score of 0.1583 ranked 4 and had the least compression and the greatest difference with the smart growth criteria.

Table 10. Indicators used in the ranking of urban areas of Rasht by the TOPSIS model (Zarrabi *et al.*, 2011)

Indicator	Sub-Indicator
Physical Criteria and Land Use (31 Criteria)	demographic gross density, extent of the district to the city, per capita residential use, residential utilization share, per capita commerce, commercial share, per capita education, educational contribution, per capita culture, cultural contribution, per capita health, per capita sports, sports contribution, per capita recreation, recreational contribution , per capita higher education, higher education share, per capita administration, administrative share, per capita service , service share, per capita industry, industrial share, per capita facilities, share of facilities, per capita transportation, share of transportation, per capita storage, share of storage, per capita urban, urban contribution
Socio-Economic Indicators (11 Indicators)	population share, number of households, household share, household size, reversal of household size, number of households in residential units, literacy rate of regions, percentage of employed people to a decade population, male employee ratio, female employees ratio, percentage of students
Access Network Indicators (14 Indicators)	per capita use of passageways, user share of passageways, per capita parking, parking use share, number of parking lots to ten thousand people, percentage of parking capacity, parking ration to cars, asphalt road area, asphalt passage ratio to area of the district, pedestrian walkway area, pedestrian crossings ratio to district, per capita car ownership, total generated trips, travel rate
Environmental Criteria (11 criteria)	per capita park and green space, share of park and green space, per capita nature, natural contribution, per capita outdoor space, open space share, per capita arid and ruinous, arid and ruinous share, per capita waste production, waste generation, reversed per capita waste production

Table 11. Results from multi-criteria ranking of TOPSIS ranking software in Rasht urban districts.

Criteria	Physical Criteria		Socio-Economic Criteria		Environmental Criteria		Access Indicators		Mixed Criteria	
District	TOPSIS	Rank	TOPSIS	Rank	TOPSIS	Rank	TOPSIS	Rank	TOPSIS	Rank
1	0.1583	4	0.7171	2	0.6654	1	0.3429	3	0.3654	3
2	0.3200	3	0.0933	4	0.2987	4	0.7264	1	0.4262	2
3	0.7878	1	0.3403	3	0.3575	3	0.4384	2	0.6021	1
4	0.3542	2	0.8665	1	0.5101	2	0.2535	4	0.3550	4
Average	0.4051		0.5018		0.4579		0.4403		0.4372	

In all districts of the city, the average score of 0.4051 indicates the greater dispersal of the landuse comparing to their density in the city due to the presence of arid lands and farms in the periphery of the northern part.

In economic and social criteria, among the four districts of Rasht, the district 4 with the top TOPSIS score of 0.8565 and the highest density and adaptation with the socio-economic criteria of the smart growth strategy is ranked one. So it is more densely populated than the other districts of Rasht, due to the geographical location and the marginal feature of the district.

District 2 with the score of 0.2987ranked 4 and had the lowest density and the average score of the total districts as 0.5018 represents a relative and balanced density and compaction in the economic and social criteria in the metropolis of Rasht. Regarding the environmental criteria, district 1 with a score of 0.6654 benefits from one of the most compacted open spaces, parks, gardens, green spaces, streams, and water canals and has the highest compatibility with environmental indicators than other districts of the city. The district 2 with a score of 0.09333 is ranked 4th and has the least compression and compatibility with the environmental criteria. The average TOPSIS criterion in this field with a score of 0.4579 indicates the low density of this index, dispersed distribution of natural and environmental spaces, in the city of Rasht, and the least environmental indicators of the urban smart growth. In the access network criteria, district 2, with the TOPSIS score of 0.7664, is the first and has the highest density and the access to the road network, urban access facilities, and a good status compared to the other districts of the city, and district 4 with a score of 0.2535 is ranked 4 and has the least compression and availability of access networks and urban transport facilities. The average TOPSIS index with a score of 0.4403 notifies the undesirable and unbalanced distribution of urban areas considering the transportation access network and dispersion of this index. In the final ranking of the districts of Rasht in accordance with the urban smart growth criteria, with the involvement of all 67 factors in the TOPSIS model, through the entropy weighing and mixed method, district 3 with the TOPSIS score of 0.6021 ranked one having the highest compression and adaptation with the urban smart growth criteria and the 4th district with a score of 0.3550 ranked 4th and has the least compression and the most sprawl. Considering the average mixed indicators with the TOPSIS score of 0.4373, it can be said that the city of Rasht has a dispersed urban growth in its physical and spatial development, and it does not enjoy the compactness and density of the urban smart growth criteria. Due to the lack of a detailed plan for District 5 and the completely dispersed texture, this district was not included in the Holdern model (Table 11).

6. Conclusion and recommendation

The widespread urbanization has led to massive changes in cities. Sprawl of big cities, lack of identity in them, their historical disruption, the emergence of environmental and demographic crises with many adverse effects, are some of the problems resulted from these changes. New urban strategies such as the smart development strategies have been proposed to organize this rapid growth. Achieving an appropriate model for organizing and controlling the growth and development of a city in accordance with the indicators and principles of the urban smart growth in various physical, social, economic, and environmental dimensions requires the accurate recognition of the current status of the city and the analysis of its features in different dimensions. The smart growth strategy as an effort to promote dense urban neighborhoods, in contrast to sprawl, through consolidating and integrating the various dimensions of urban life provides the context to alertly control the growth of neighborhoods and urban areas. Supporting economic development and creating a variety of choices, it also makes possible to achieve a healthy city. The smart growth by integrating urban transport system and urban mixed landuse combats vehicle oriented and dispersed urban development. It occupies a lesser level of land utilizing by a vertical and dense development pattern and improves quality of urban life, diversity of design, economic empowerment, environmental issues, health and public health and diversity of public transportation practices. Smart growth by increasing access, reduces travels, thereby reduces air pollution and energy consumption. Given the fundamental role of physical, socio-economic, access, and environmental indicators in the smart growth strategy, issues such as the diversity of land use, access levels, environmental quality and population density, in this strategy are especially significant.

As mentioned before and following the physical-spatial development patterns in different periods, the area of the city has increased from 650 hectares to 10240 hectares from 1955 to 2006, which indicates 1.575 percent of spatial growth during those years. This may be the source of many changes in the population and building density of Rasht and its sprawl.

For physical analysis of the city form, and planning the future spatial and physical development of the city, analytic models were used. Holdern analytic model, Shannon entropy, and TOPSIS ranking were used to analysis the extent of sprawl in the districts of Rasht and their degree of compatibility with the criteria of the smart growth.

The results of the Holdern model about the physical development of Rasht in the period 1956-2011 show that it was 64% due to population growth and 36% due to the horizontal expansion of the city. That is, during this period Rasht has expanded its sprawl farms. The results of the Shannon entropy model also indicate the horizontal and dispersed growth of Rasht in districts 1 to 4 and show the dispersion of Rasht more than its compactness. According to Shannon entropy analysis, district 2 has the highest compaction and adaption with the smart growth criteria.

In the study of the compatibility of the four districts of Rasht with the smart growth criteria, using multi-criteria TOPSIS ranking and multi-criteria ranking of entropy weights and considering all the smart growth criteria, it was determined that Rasht, with the average TOPSIS score of 0.4373 in its physical and spatial development, has grown sporadically and lacks compaction and density of the urban smart growth indexes. District 3 with the top score of 0.6021 has the highest density and adaptation to the smart growth criteria and district 4 with a score of 0.3550, after the scattered context of district 5, has the greatest difference and dispersion with the smart growth criteria.

According to analytical results, in order to achieve sustainable urban development in strategic planning of future development of Rasht and similar cities, it is recommended to use smart growth approach. Therefore denser neighborhoods should be created, public transport should be strenghtened, and the cost of public services should be reduced in order to prevent urban sprawl and improve the quality of urban life.

Notes

[1] APE: American Planning Association

[2]ICMA: International City/ Country Management Association

3 TOPSIS: Technique for Order of Preference by Similarity to Ideal Solution

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Received: 9 March 2018 • **Revised**: 4 April 2018 • **Accepted**: 4 May 2018