Research Paper: Studying the Sprawl Level of Rural Growth Patterns around Tehran Metropolis

Esmaeel Adinehvand[1*], Abdorreza Roknoddin Eftekhari[2]

1. PhD Student, Department of Geography, Faculty of Humanities, Tarbiat Modares University, Tehran, Iran.
2. Professor, Department of Geography, Faculty of Humanities, Tarbiat Modares University, Tehran, Iran.

Use your device to scan and read the article online

Citation: Roknoddin Eftekhari, A., & Adinehvand, E. (2019). Studying the Sprawl Level of Rural Growth Patterns around Tehran Metropolis. *Journal of Sustainable Rural Development, 3*(1-2), 15-30. https://doi.org/10.32598/JSRD.02.02.20

doi: https://doi.org/10.32598/JSRD.02.02.20

Article info:
Received: 16 Apr. 2019
Accepted: 28 Sep. 2019

Keywords:
Smart growth, Rural, Sustainable development, Tehran metropolitan

ABSTRACT

Purpose: This research aims to first discover the pattern of rural development around Tehran metropolis and then compare the finding with smart growth principles; finally, it assesses the impact of sustainable development factors on rural growth patterns.

Methods: In this study, library research, document reviews, structured interviews and questionnaires were applied to collect data. The present study is a quantitative one regarding the nature and method of data collection. The statistical population of this study consists of the villages around Tehran metropolis that have a population growth rate above 3% and the population between 10000-1000 having local management. Radar and SPSS software were used to analyze the collected data.

Results: Villages around Tehran metropolis failed to adapt to smart growth principles, Therefore, the growth pattern of the rural areas around Tehran metropolis is a diffuse growth pattern. Moreover, the physical dimension of sustainable development had the greatest impact on the growth pattern of rural areas.

Conclusion: The proximity of villages to the metropolis of Tehran has made them more vulnerable to drastic changes and the growth pattern of the villages tends towards the sprawl growth pattern. In fact, villages affected by the metropolis of Tehran have a scattered texture, high population growth, reduced agricultural land area, high physical growth rate, environmental pollution, visual pollution, etc. In fact, based on the principles of smart growth pattern, the evaluation of the villages around Tehran metropolis reflects the fact that these villages follow a sprawl growth pattern in which the rural programs have not been able to move within the framework of sustainable development.

*** Corresponding Author:**
Esmaeel *Adinehvand, PhD Student*
Address: *tehran, south rodaki, ally mahtab, N3*
Tel: *+98 (916) 3608789*
E-mail: *adinehvand2008@gmail.com*

1. Introduction

Although Peri-urban villages are heavily influenced by the growth and expansion of cities and their relationships with their development path, this impact is more pronounced in the form of population growth and physical expansion of rural settlements around the cities (Ghadramarzi & Afshari, 2008: 69). Being affected by the population and physical growth, in many cases, the peri-urban villages change rapidly by the spatial restructuring triggered by the effects of the central city (Ravetz & Loibl, 2011). Moreover, they have little to do with economic and social development within the framework of sustainable rural development. These villages often face numerous challenges such as environmental pollution, inappropriate land use, excessive use of cars, unnecessary exploitation of resources, shifting the economic structure from a production-based economy to a consumer-dependent economy, weakening of the villages' cultural traditions and the demise of long-standing traditions of rural cooperation and partnership that pose many challenges to the sustainable development of rural settlements (Safari, 2014: 2). This change is happening in the villages around the big cities because of population density and activity, non-compliance with the principles of resource utilization, environmental health and waste management, pollution spreading across the environment, reduced levels of agricultural land and rangelands as a result of changes in construction, and the disruption between integrated environmental components including fundamental environmental issues (Hesam et al., 2014: 65). The Smart Growth Pattern is a framework to measure the growth pattern of settlements which covers a range of sprawl to smart growth. The purpose of this study was to measure the deviation of growth pattern in rural areas from smart growth model. Rural- sprawl takes two forms. The first is low-density residential development that is scattered outside villages, suburbs, and smaller cities. The second rural sprawl is commercial highways leading into smaller cities. Strip development along the type of arterial out of villages, suburbs, and smaller cities. Rural sprawl creates a host of planning challenges. Rural residential sprawl usually occurs away from existing central sewer and water. Homeowners rely on on-site septic residence. The demand for 2 to 10 acre house lots has driven up land prices in rural fringe areas beyond what a farmer or forester can afford to pay. Moreover, as land prices rise, farmers and foresters are more likely to sell their lands for house lots. This, in turn, causes a greater fragmenting of the land base, making it more difficult for remaining farmers and foresters to assemble land to rent. Rented land is especially important for commercial farming (Daniels & Bowers, 1997:11). There are several factors that are combined to create rural sprawl. Sprawl does not just happen. Some of the factors affecting the rural sprawl growth include:

- individual tastes and preferences
- Weak local planning and zoning
- Proximity to metropolises
- Population growth
- The expansion of rural-urban relations
- Rural land speculation (Daniels, 1999: 4).
- Fewer farms and fewer farmers
- Loss of forest land
- Rapid growth at metropolitan edges
- population drop in other areas
- Access to jobs and services and lack of transportation options
- Limited planning capacity (ICMA, 2010: 3-5).

The metropolis of Tehran is one of the metropolises of the country whose process of transformation from rural to urban in its surrounding territory has been growing and expanding in recent decades. The overflow of development from populated areas to weak growth control in conditions of political divisions and multiplicity of local management territories in the metropolitan area of Tehran leads to the expansion of peri-urban areas and consequently to the physical expansion of villages in the metropolitan areas of Tehran. Therefore, this trend demonstrates the need for proper planning and modeling for the pre-urban villages in order to avoid the consequences of sprawl growth and access to quality of life. Yet the need for rural smart growth strategies is clear: rural towns are at the very edge of tomorrow's sprawling development. Some rural communities have mobilized around their concerns about growth and its effect on traditional town centers, natural resources, and working landscapes. These concerns spur innovations in planning for growth and leveraging a wide variety of financial and technical resources.

In such circumstances, the correction of the effects of irrational scattering is inevitable, but strategies such as smart growth, green belts, and ground-based user planning have been considered. As solutions to environmental, social (creating a healthy social environment, social solidarity), economic (strengthening the local economy), and physical (avoiding sprawl) problems, as early as 1970, urban and transport planners began to promote the idea of compact communities; then Peter Caltorp's idea of "rural-urban" city based on public transport, walking and cycling rather than using cars emerged, and the US Environmental Protection Agency also promoted "smart growth" as a way to reduce pollution, make good use of lands, reduce public spending, maintain proposed environment and improve environmental quality (Walmesley, 2006:13). Accordingly, the present study seeks to evaluate the villages around Tehran metropolis based on the principles of smart growth and in the next step, to identify the most important factor affecting rural smart growth. The villages around Tehran metropolitan area are affected by the complex flow and communication with this metropolis, such as increased speed of personal car use, physical expansion, out-of-town construction, land value inflation, environmental pollution, rising costs, unstable employment, housing problems, etc. Therefore, the main question of this study is how far the growth pattern in these villages is from the smart growth pattern. In other words, to what extent does the pattern of growth in rural areas around Tehran's metropolis follow the pattern of sprawl growth?

2. Literature Review

Smart growth

There is no general agreement on what sprawl is, making debates over the phenomenon frustrating and counterproductive at times. Definitions range from those which are as simple as dispersed, low density residential development (Speir & Stephenson, 2002) to more elaborate and quantitative definitions such as non-contiguous, subdivision-style residential development on 0.33 to 1 acre lots or non-residential development with floor-to-area ratios of 0.20 or less (Burchell & Mukherji, 2003). Sometimes, density linked descriptors are avoided, and instead, sprawl is defined as unattractive, poorly planned growth that consumes valuable green space (Tregoning, Agyeman & Shenot, 2002). Couroux et al states that the term "sprawl" will refer to low-density, automobile-dependent development based on segregated land uses. Slaev and Nikivorof (2013) describe the characteristics of sprawl as low density in new development areas, patchy and scattered forms with discontinuity tendencies; lack of differences in land use and urban activity, lack of good definition, the growth of centers, public service and trade centers; less affordable by public transport services.

Contrary to the concept of sprawl growth, smart growth is represented. Smart growth emerged as an answer to the enduring problem of sprawling development and its many negative consequences. Its historical antecedents are varied and numerous, dating back to some decades ago, including national land use efforts, state growth management laws, housing reforms and anti-exclusionary zoning mandates (Burchell et al., 2000). Although the roots of the smart growth movement are deep, the passage of the Smart Growth and Neighborhood Conservation Act in Maryland in 1997 was significant in launching into the public policy arena and into the mainstream media. Maryland's law encourages targeting development to priority funding areas, preserving rural lands, encouraging redevelopment, and living near your workplace, among other goals. Other key catalysts of the smart growth movement include the Growing Smart project initiated by the American Planning Association (APA) in 1994, and several years later resulting in the publication of the Growing Smart Legislative Guidebook: Model Statutes for Planning and the Management of Change (2002). This guidebook updates land use controls to allow them to address problems of resource depletion, traffic congestion, lack of affordable housing, and redevelopment better. The Natural Resource Defense Council, together with the Surface Transportation Policy Project, also released a toolkit to assist decision-makers in promoting compact growth and mixed lands used in pedestrian-friendly environments (Burchell et al., 2000). Since the introduction of these initiatives, multiple organizations have emerged and coalesced to promote the smart growth agenda and many have developed their own definitions of smart growth accompanied by their own sets of goals and policies.

The term, smart growth, was first used in relation with the Maryland state plan under the governor Parris Glendening (Levy, 2008). Burchell et al. (1999) defined smart growth as the growth that is opposed to sprawled growth, it is the redirection of growth portion to the inner metropolitan area, combined with a more controlled movement outward; it would consume far less capital and fewer natural resources enabling the achievement of more ambitious development goals. A similar statement was made by Downs (2005, 367), who contended that "smart growth was originally conceived as a reaction to what many planners believed were undesirable features of continuing growth through suburban sprawl".

The definition from Smart Growth Network states that smart growth is the growth "which gives us great communities, with more choices and personal freedom, good return on public investment, greater opportunity across the community, a thriving natural environment, and a legacy we can be proud to leave for our children and grandchildren." (Smart Growth Network, 2006). The U.S. Environmental Protection Agency also gives a broad definition of smart growth which covers a range of development and conservation strategies that help protect our natural environment and make our communities more attractive, economically stronger, and more socially diverse (EPA, 2008). Smart growth creates accessible land use patterns, improving transportation system, viable communities and reduction of public service costs (zamanian et al, 2015). Indeed, the American Planning Association's (APA's) (2002) definition of smart growth is largely a narrative of problems and goals which it seeks to address, embracing most advocates' interests: 'smart growth is the planning, designing, developing and revitalizing cities, towns, suburbs and rural areas in order to create and promote social equity, a sense of place and community, to preserve natural as well as cultural resources. Smart growth not only enhances ecological integrity over both the short and long term, but also improves quality of life for all by expanding, in a fiscally responsible manner, the range of transportation, employment and housing choices available to a region' (APA 2002: 1). In fact, Smart growth" as opposed to sprawl growth has captured the imaginations of citizens, planners, environmentalists, and policymakers throughout the nation. This evolving approach to land development and redevelopment promotes a mix of residential, commercial, and recreational uses; preserves green space and working landscapes; and provides a variety of transportation choices. It appeals to cost-conscious communities by maximizing the use of existing infrastructure - highways, transit, schools, sewer systems, and every type of public service. It also protects air and water quality by conserving undeveloped land; minimizing the spread of paved, impervious land cover; and offering alternatives to automobile travel that reduce traffic congestion and the number of vehicle miles traveled (Wells, 2002: 3) (Table 1).

Table 1. Between smart growth strategy and sprawl in development

Index	Sprawl Growth	Smart Growth
Density	Low density, scattered activities and Central compact development constructions in urban and suburbs areas	Central compact development
Growth pattern	Developments in suburbs areas	Development within the context
Mixing uses	homogeneous, similar, and single- function land use	Mixing land use
Scale	Big scale, buildings, big blocks, wide paths	Human scale, buildings, blocks, small paths
Public services (stores, schools and parks)	Regional, solid, bigger, needing cars accessibility	Local, smaller, compatible with pedestrian accessibility
Transportation	Transportation based on cars and land use patterns without paying attention to pedestrian-oriented standard spaces	Providing different transportation ways and land use patterns that lie on using bicycle and pedestrian-orientation
Accessibility and connections	Hierarchical road network with lots of rings and vast streets and unconnected sidewalks, existence of obstacles on non-motoring trips	Sidewalks and paths suitable and connected to each other which makes it possible to have journeys cars or elseby
Public spaces	Emphasis on private areas (malls, closed spaces)	Emphasis on public areas (sidewalks environment, parks and public services)
Programming process	Not programmed	programmed

Source: Litman, 2013:8

Porter argues that 'smart growth abides by a set of interrelated principles of development '(Porter 2002: 1). Smart Growth employs a set of core principles that can be adapted to the specific conditions and circumstances of the location where they will be employed (Halligan, 2000). The original ten principles developed by the Smart Growth Network include:

1. Mix land uses such as residential units and employment centers

2. Take advantage of compact building design

3. Create a range of housing opportunities and choices

4. Create walkable communities

5. Foster distinctive, attractive communities with a strong sense of place

6. Preserve open space, farmland, natural beauty and critical environmental areas

7. Strengthen and direct development toward existing communities

8. Provide a variety of transport choices

9. Make development decisions predictable, fair and cost-effective

10. Encourage community and stakeholder collaboration in development decisions (Tregoning et al., 2002).

These 10 principles show the recognition of importance and the value of smart growth, and the importance to make smart growth real (yang, 2009: 41).

Organizations such as the Pembina Institute, Smart Growth BC, Smart Growth America and the Sierra Club have modified these principles somewhat, and they vary even more in areas where governments have put them into practice. Ye et al. (2005) contend that in some cases the term Smart Growth is being used, often by governments, to promote initiatives inconsistent with and even contradictory to Smart Growth objectives. They compared the definitions of ten national organizations in the United States and identified six focal points of implementation common among all groups, as well as 25 more specific components that have been used to guide actions to achieve Smart Growth objectives. The six major focal points of Smart Growth implementation and their associated components are shown in the chart below (Table 2).

Table 2. Modified smart growth principles

Planning	**Natural Resources Preservation**
Comprehensive Planning	Farmland Preservation
Mixed Land Use	Subdivision Conservation
Increased Density	Easement Conservation
Street Connectivity	Transferable Development Rights Systems
Integration	Purchase of Development Rights
Alternative Infrastructure and Systems	Historical Preservation
Public Facilities Planning	**Ecological Land Preservation**
Economic Development	Housing
Neighborhood Business	Multifamily Housing
Downtown Revitalization	Smaller Lots
Use Existing Infrastructure	Housing for Special Needs/Diversity
Community Development	**Transportation**
Encourage Popular Participation	Pedestrian station
Recognize/Promote Unique Communities	Facilities for Bicycling, Public Transit Promotion

Source: Couroux et al., 2006: 11

Sustainable and smart growth

Smart Growth is a set of sustainable development principles attracted wide recognition in the mid-1990s (Knaap & Talen, 2005; Tregoning et al., 2002; Ye, Mandpe, & Meyer, 2005). The relationship between smart growth and sustainability is a controversial issues as some articles claim that smart growth and sustainable development are similar. Smart growth and sustainability both showed their concern about environmental degradation and resource exhaustion, and both called for a wise development (yang, 2009: 46). Therefore, 'many sustainable development aims are reflected in smart growth principles' (Porter, 2002: 5). There is an argument that 'Advocates share many of the same goals of earlier anti-sprawl efforts fought under the banner of sustainability' (Tregoning, Agyeman & Shenot, 2002: 341). At the same time, there are arguments that went even further which claimed that these two concepts had parallel definitions. For example, EPA considered smart growth as 'the development that serves the economy, the community, and the environment' (EPA, 2009: 1). This general definition divides smart growth into four arenas which are closely related to the 4Es of sustainable development. Furthermore, there are also academics and practitioners who treated these two concepts similarly because they thought that one concept was actually the approach to achieve the other. On the one hand, smart growth could be just a sustainable development strategy.

In Taking Sustainable Cities Seriously, Portney considered smart growth as one dimension of sustainable development- economic growth. Smart growth is 'sustainable conceptions of economic development' (Portney, 2003, 104). On the other hand, some groups, like the European Union, defined sustainable development as a smart growth strategy. However, this definition is based on superficial understanding of smart growth. Since its purpose is to 'embrace the idea of sustainable development as the way forward the European economy', defining sustainable development as a smart growth strategy is just to 'adopt the new buzzword' (Begg & Larsson, 2005, 4). However, an overwhelming number of articles argue that the concepts of smart growth and sustainable development may overlap in some point, but they are two independent concepts. Compared with smart growth, sustainable development is more comprehensive but has less support. Sustainability recognizes the broad spectrum of impacts to the earth's resources, and the advocates of sustainability attempt to mitigate these impacts by focusing on limiting resources consumption, and relating this consumption with development and growth. They also consider economic and equity issues associated with planning of communities. Although smart growth programs have largely ignored the early sustainable development focus on conserving and recycling natural resource, they have paid little attention to the current sustainable development emphasis on interrelating and balancing economic prosperity, the integrity of ecosystems, and social equity (Zovanyi, 2004) (Table 3).

Rural smart growth

Although suburban and urban communities increasingly recognize and use the hallmarks of smart growth -such as collaborative planning, mixed-use development, downtown revitalization, and open-space conservation- these tools are not as widely applied to rural areas (Wells, 2002: 3). Suburban and urban communities increasingly recognize and use the hallmarks of smart growth -such as collaborative planning, mixed-use development, downtown revitalization, and open-space conservation- these tools are not as widely applied to rural areas. It may be more difficult for rural communities to embrace and implement smart growth if they cannot envision the long-term consequences of building a new mega-mall or believe they have an inexhaustible land supply to develop. Rural communities also may lack the funding and organization that requires comprehensive planning.

Smart growth per se is thus not specifically defined, with the consequence that cannot be directly measured. Likewise, the role played by different types of amenities is not explicitly pointed out as a key driver to achieve rural growth, rather it is left unspecified and assembled in the broad concept of place-based characteristics. Furthermore, how intermediate and isolated regions are defined and whether there are any categories between these two types has not not discussed in prior literature. Hence, it is still unclear whether smart growth policies are appropriate for many rural regions (Naldi et al., 2015: 91). But it is important to note that most rural communities want to both maintain their rural character, and also strengthen their economies. Many fast-growing rural areas are now at the edge of major metropolitan regions and face metropolitan style development pressures. They seek to manage growth in a way that promotes prosperity yet is sustainable over the long run. Fortunately, a variety of proven tools and strategies can help rural communities thoughtfully consider how and where to grow. For example, communities that want to maintain their rural character and economic vitality could decide to adopt mixed-use zoning for their main street buildings and commercial areas, policies to better manage storm water

runoff, and design requirements for complete, connected streets. Strategies like these are used in communities of all sizes around the country. Small towns and rural areas generally have fewer financial, technical, and human resources to draw on in response to development proposals and growth pressures than their urban and suburban counterparts. As a result, rural communities need to identify strategies that are able to implement with their resources (Nelson, 2012: 1). However, it can be said that Smart growth approaches to development benefit the community, the environment, the economy, and public health. Rural communities hoping to implement smart growth approaches must strategically facilitate community decision making and policies and make most natural features and amenities, recognizing that no community has endless resources. If rural communities are to meet the broad challenge of maintaining rural character while also supporting economic growth and opportunity, they require a set of tools that can be adjusted to reflect the diversity of rural communities which can be applied to both expanding and contracting economies (Table 4).

Table 3. Linking sustainability dimensions, sustainable indicators, sustainable development goals and smart growth principles

Sustainability Dimensions	Sustainability Indicators	Sustainable Development Goals	Smart Growth Principles
Environmental	Water Quality Green/Open Space Energy Consumption Ecosystem Integrity & Diversity Soil Quality Air Quality Solid Waste	*Protect open space and working landscapes *Protect environment sensitive areas *Promote energy and resource efficiency	*Creation of neighborhoods that are walkable *The preservation of farmlands, open spaces, natural beauty and important environmental areas
Physical	Land use access Transportation Housing Ownership Productivity of land Structural quality Physical Development	* Decrease sprawl * Housing needs * Physical Development Control * Access to services * Texture improvement * Save transportation cost	*Mixed-use development *Compact development/building design *Intensifying and directing development toward existing communities *Provision of a variety of transportation options *Range of housing choices and opportunities
Social	Awareness social participation Sense of Place Citizens' Health Public Security Culture / Heritage Public Service	*Promote equitable Development	*Encouraging community and stakeholder participation in development decisions *Fostering of unique and attractive communities with a strong sense of place
Economic	Wealth distribution Poverty Infrastructure Access to capital Retail Income work force Supporting human capital business activity Food production	*Create strong local and regional economies	*Providing conditions for raising funds and improving local economy

Source: yang, 2009; Mohammed et al., 2016

Table 4. Goals, Strategies, and Policy Tools for Rural Smart Growth

Goal1	Goal2	Goal3
Support the Rural Landscape Create an economic climate that enhances the viability of working lands and conserves natural lands.	**Help Existing Places Thrive** Take care of assets and investments such as downtowns, main streets, existing infrastructure, and places that the community values.	**United States Environmental Protection** Agency(EPA) Build vibrant, enduring neighborhoods and communities that people, especially young people, don't want to leave.
1.a. Ensure the viability of the resource economy in the region	2.a. Invest public and private funds in existing places	3.a. Update strategic and policy documents to accommodate new growth through compact and contiguous development
1.b. Cultivate economic development strategies that rely on traditional rural landscapes	2.b. Encourage private sector investment	3.b. Reform policies to make it easy for developers to build compact, walkable, mixed-use places
1.c. Promote rural products in urban areas and support other urban-rural links	2.c. Build on past community investments	3.c. Recognize and reward developers that build great places using smart growth and green building approaches
1.d. Link rural land preservation strategies and green building approaches to great neighborhoods	2.d. Foster economic development in existing downtowns	

Source: ICMA, 2010: 8

JSRD

A rural community that uses smart growth approaches has a vibrant downtown, with historical buildings that have been preserved, a walkable main street or two, and compact neighborhoods surrounding the downtown. It is a place with a small-town feel and the sense of community that is developed when you know your neighbors. Residents gather for important events such as shopping and participating in civic activities. The local economy -whether it is built on resource extraction, tourism, or new economic opportunities- celebrates, protects, and supports the use of the land. Local businesses are encouraged to flourish, particularly those ones that support the rural identity of community. Housing options support a variety of financial and lifestyle choices, whether old or newly constructed, in town or the countryside, in modest apartment buildings or single-family homes. Underutilized lots in already developed areas are reused whenever possible, especially before using valuable undeveloped property for new construction, to control infrastructure costs, to preserve pristine land, and to provide more options for transportation. The community has articulated its joint vision for the future in policy documents so that developers and the broader stakeholder community alike have some predictability. With such a vision in mind, it becomes clear that smart growth strategies enable the entire community to benefit from its local rural heritage and resources, just as all can share jointly in its development and conservation (ICMA, 2010: 6).

Smart growth approaches to development can help achieve the vision of vibrant, thriving rural communities outlined in the paragraph above. One way to structure a rural smart growth approach is to use the following three goals as a framework for future growth in rural communities:

1. Support the rural landscape by creating an economic climate that enhances the viability of working lands and conserves natural lands;

2. Help existing places thrive by taking care of assets and investments such as downtowns, main streets, existing infrastructure, and places that the community values; and

3. Create great new places by building vibrant, enduring neighborhoods and communities that people, especially young people, do not want to leave (EPA, 2008).

Study area

Tehran province covers an area of 13.8 thousand square kilometers which is located between 34 degrees 52 minutes to 36 degrees 8 minutes' north latitude and 50 degrees 19 minutes 53 degrees 10 minutes' east longitude. The province is bordered by Mazandaran province to the north, Qom province to the southeast, Markazi Province to the southwest, Alborz province to the west and Semnan province to the east. According to the latest country divisions, Tehran province has 16 counties, 33 districts, 44 cities and 1034 villages (Statistical Yearbook, 2016). The research statistical community in this study is peri-urban villages of Tehran metropolis which -are influenced by Tehran metropolis- tend to increase the population, physical growth and expansion. Due to the importance of spatial distribution of the research com-

munity, Tehran province is zoned to select sample villages based on the storages method (Pourtaheri, 2005, 35).

Sturges Rule $K=\frac{1}{2}\log R+4\log N$

In which K stands for the number of classes, R is the amplitude of the fluctuations, and N is the volume of the population. The length of Tehran province is 271 km (N = 271), the distance from the nearest village to Tehran metropolis is 13 km while the furthest village is 155 km (R = 142). Therefore, according to calculations, the value of K is 36 km. In the next step, using Multiple Ring Buffer in the ARC GIS10.5 software environment, multiple buffers were applied at a distance of 36 kilometers from Tehran metropolitan center and based on concentric circles. Tehran province was divided into 5 regions. According to the spatial diffusion theory, if we consider Tehran metropolis as the center of diffusion, based on the extent and intensity of the relationships, its subordinate villages will be affected by different proportions of Tehran metropolis. Thus, the villages in zones 1, 2 and 3 were the criteria for sample village selection because they are more susceptible to drastic changes and sparse growth than other zones. In the next step, villages with a population growth rate of more than 3% (Census, 2006-2016), population between 10000-1000 (Census, 2016) and Rural Development Plan (Census, 2016) were recognized for sample village selection. By overlapping layers and applying the queries mentioned above, 9 villages in Zone 1, 5 villages in Zone 2 and 1 Village in Zone 3 and 15 villages in total, were selected (Figure 1).

According to Cochran formula, out of 41845 people, 378 people were identified as the sample population. Considering the population share of each village, a specific sample number was considered for the villages. Table 5 shows the population of the village and the number of samples per village.

3. Methodology

The purpose of this study is not only to identify ten principles of smart growth based on the typology of rural areas of the country but also to evaluate the metropolitan villages of Tehran metropolis based on these indicators. Finally, the impact of sustainable development dimensions on the rate of smart growth of the villages is evaluated to determine which dimensions have the highest impact. The general approach of this research is quantitative research and in terms of data collection, it is based on library-document review and field survey. Specifically related studies were used to identify smart growth pattern indicators (consistent with rural areas of the country). Then, the indicators were refined according to the experts in the field of rural studies. Accordingly, the identified indices were based on questionnaire design (as a research tool). Questionnaires were completed at household, government managers and field survey levels. Radar test was used to analyze the data and determine the level of smart growth of the studied villages. The output of the radar test shows the values ranging from 0 to 1 for each smart growth index. The Prescott Allen spectrum was used to convert radar test output to qualitative values (Table 6).

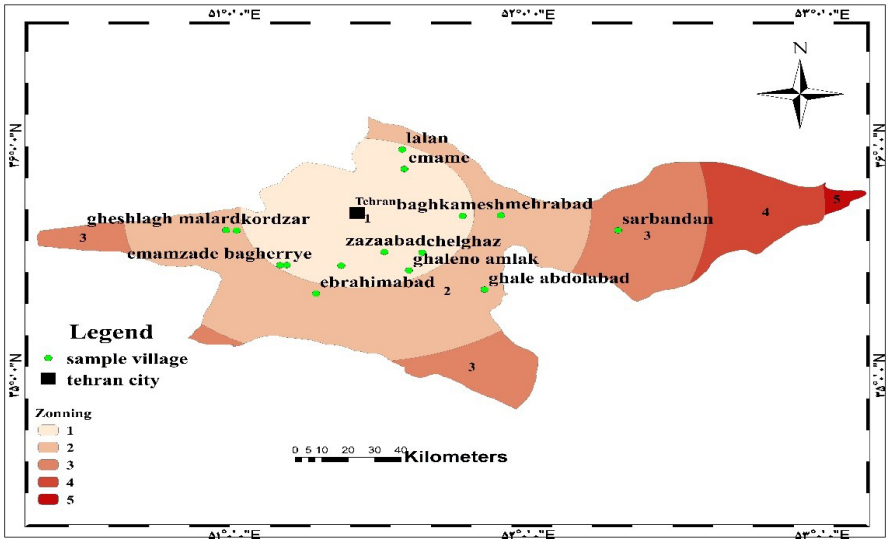

Figure 1. Location of sample villages in Tehran province

Table 5. Studied villages and sample numbers

village	population	sample
ebrahimabad	3530	32
Emamzade bagher	1134	10
Emame bala	1315	12
Bagh kamesh	2566	23
chelghz	2466	22
rye	1532	14
zamanabad	4000	36
sarbandan	3352	30
Gheshlagh malard	5110	46
Ghale abdolabad	1060	10
Ghaleno amlak	3432	31
Ghaleno chaman	1331	12
Kordzar	4594	42
Lalan	1135	10
Mehrabad	5278	48

Source: Iran statistical center, 2016

Table 6. Allen Prescott's Five Values Divisions

level	value	rating
Sprawl growth	0-0.2	5
Potential sprawl Growth	0.21-0.4	4
middle	0.41-0.6	3
Potential smart growth	0.61-0.8	2
Smart growth	0.81-1	1

Source: André Cavalcante et al., 2018

As mentioned, smart growth is derived from sustainable development which is based on economic, social, physical and environmental dimensions. Accordingly, smart growth is conceptualized as integrating social, economic, physical, and environmental factors into one integrated whole, therefore, when evaluating rural smart growth, this evaluation should include a system of indicators across all four dimensions. Stepwise regression test was used to determine the effect of each factor (social, economic, physical and environmental) on the growth pattern of the studied villages (Table 7).

4. Findings

Regarding the radar test results, it can be said that in terms of mixed-use, compact development, optimal housing, attractive community and environmental quality, the best situation belongs to Zaman Abad, Lalan, Bagh Kamesh, Ghaleno Amlak, Amame Bala and Mehrabad villages. But in terms of the principle of internal development, the best situation is in the village of Chelghaz and the worst situation is in the village of Kordzar. In terms of transportation, the best situation belongs to the village of Emamzadeh Bagher and the worst situation belongs to the village of Lalan. In terms of the principle of social participation, the highest participation is recorded for the Emame Bala. Besides, in terms of investment principle, all villages are in poor condition, but Zaman Abad village is in relatively better conditions (Table 8).

Table 7. Smart Growth Indicators Based on Studies and Rural Studies Experts

Sustainability Dimensions	Smart Growth Principles	index
Environmental	*Creation of neighborhoods that are walkable	Appropriate sidewalk coverage level /Proportion of people traveling to get different services and going to the workplace /Proper and secure sidewalk separation /Sidewalk security /Shaded sidewalks /Use of smart technology /Internet access and speed
	*The preservation of farmlands, open spaces, natural beauty and important environmental areas	Per capita greenery, green landscape of streets, preventing invasion of green spaces and natural resources, preventing the penetration of village textures into agricultural lands, caring for rural green space, waste collection system, unhealthy air days, distance Landfill from village, Landfill distance from village drinking water source, Waste and unpleasant odor in village, Ratio of trash to village population, Organic crop production approach, Sewage disposal system
Physical	*Mixed-use development	Multifunctional Buildings /The Share of Types of Functions
	*Compact development/building design	Population density /Multifamily housing /two-story buildings and more/residential density
	*Intensifying and directing development toward existing communities	worn-out texture area/ residential units outside the Rural Development Plan/ population outside the Rural Development Plan/ number of maladaptive uses in the village (slaughterhouse, cemetery, etc.)/ monitoring of construction for physical guidance Village/ rate of change of area of the village
	*Provision of a variety of transportation options	Taxi station access distance/ bus station access distance/ quality of public transport access/ use of public transport/ public transport costs/ waiting time for public transport
	*Range of housing choices and opportunities	Housing Facilities/ Housing Ownership Status/ Acceptance of Housing Pattern and Architecture/Durable Housing / Housing Benefits of Native and Traditional Materials/ Average Residential Distance from Educational Services/ Medium Residential Distance from Welfare Services / Medium Residential Distance from Business Services / Medium Residential distance from Behavioral health services/ Average residential distance from public transport/ Average residential distance to work
Social	*Encouraging community and stakeholder participation in development decisions	local people's participation in social activities and rural affairs/ villagers volunteering to solve village problems/ people's trust in the plans of local authorities and planners/ local people's participation by development managers in project decision making/ local people's participation By the development managers in the project implementation process/ local people's participation in the process of project implementation and maintenance/ local people's participation in the process of project evaluation/ community organizations and institutions in the village
	*Fostering of unique and attractive communities with a strong sense of place	Beauty of buildings /Visual pollution of streets /Street lighting at night /Historical and cultural elements in the village /Preservation of precious and historical monuments / Distinguished places (natural and artificial) /Specific local products (branding) /Villagers tend to migrate
Economic	*Providing conditions for raising funds and improving local economy	Job Satisfaction, Income-Cost Ratio, Livelihood Diversity, Household Savings, Unemployment Rate, Private Sector Investment in Business Creation, Public Sector Investment in Business Creation, Local Managers Performance in Fundraising, Strengths and Opportunities for Investing, Weaknesses and Threats for Investing

Source: Yang, 2009

JSRD

Table 8. Radar test values separated by smart growth principles and villages

village	mix-land use	compact development	optimal housing	walking	Attractive settlement	Environmental quality	Internal development	Transportation options	Strong social participation	Improving the local economy	Smart growth
ebrahim abad	0.346	0.134	0.063	0.465	0.239	0.284	0.406	0.042	0.289	0.131	0.24
emamzade bagher	0.156	0.25	0.12	0.392	0.072	0.142	0.084	0.343	0.189	0.075	0.163
emame bala	0.063	0.062	0.21	0.463	0.099	0.318	0.27	0.01	0.313	0.136	0.164
bagh kamesh	0.26	0.188	0.011	0.479	0.15	0.351	0.285	0.083	0.208	0.012	0.202
chelghaz	0.091	0.326	0.17	0.49	0.374	0.334	0.184	0.042	0.297	0.157	0.246
rye	0.329	0.325	0.103	0.55	0.109	0.293	0.1	0	0.213	0.151	0.217
zaman abad	0.375	0.375	0.042	0.457	0.31	0.458	0.123	0.036	0.267	0.185	0.263
sarbandan	0.024	0.293	0.129	0.469	0.125	0.33	0.26	0.219	0.262	0.008	0.21
gheshlagh malard	0.327	0.369	0.062	0.373	0.027	0.204	0.35	0.047	0.304	0.031	0.209
abdol abad	0.25	0.228	0.077	0.381	0.13	0.227	0.145	0.228	0.206	0.11	0.198
ghaleno amlak	0.213	0.191	0.086	0.214	0.18	0.294	0.171	0.102	0.186	0.096	0.152
ghaleno chaman	0.323	0.312	0.081	0.547	0.106	0.287	0.089	0.006	0.21	0.142	0.21
kordzar	0.04	0.239	0.079	0.354	0.026	0.196	0.079	0.057	0.304	0.067	0.129
lalan	0.031	0.012	0	0.424	0.187	0.25	0.284	0.004	0.268	0.034	0.148
mehrabad	0.375	0.252	0.059	0.445	0.226	0.132	0.132	0.037	0.307	0.022	0.186

Source: Authors' studies, 2019

JSRD

Comparison of radar test results with Allen's Prescott range shows that in terms of mix land use, 6 villages are in non-smart growth status and 9 villages are in potential non-smart growth status. According to the principle of internal development, 5 villages are in a non-smart growth state and 10 villages are in a potential non-smart growth state. In optimal housing principle, all 15 villages are in a poor state. In terms of walking, the situation is different for the villages, which means that 10 villages are in average conditions, this shows the relatively good situation of the villages in this index. From the perspective of the attractive settlement principle, 11 villages are in non-smart growth and 4 villages are in potential non-smart growth. In terms of environmental quality principle, one village is in medium conditions, 3 villages in non-smart growth and 11 villages in potential non-smart growth. In terms of internal development, 9 villages are in non-smart growth, 5 are in potential non-smart growth and 1 is in medium smart growth conditions. But as the results show, among the smart principles, the worst situation is related to the principles of transportation and investment, so that, in principle of transportation, 14 villages are in a state of non-smart growth and only 1 village in a potential non-smart growth situation and in terms of the principle of capital investment, all the villages are in a non-intelligent state. In terms of social participation principle, 13 villages are in potential non-smart growth and 2 villages are in potential non-smart growth conditions. Finally, considering all the principles of smart growth, all villages are in two situations: 7 villages in non-smart growth situation and 8 villages in potential non-smart growth status; none is in medium or smart growth status (Table 9).

After identifying the growth pattern of the studied villages, the next step is to discover the impact of sustainable development factors on the growth pattern of the villages in the region. In order to identify the factors influencing the growth pattern of the villages under study, indices of ten dimensions of smart growth were compiled in terms of economic, physical and social as well as environmental dimensions. Then, stepwise multivariate regression was used to investigate the relationship and the effect of these variables. In stepwise multivariate regression, 4 variables entered the equation as effective factors. As Table 10 shows, the correlation of the four

dimensions affecting the growth pattern of the villages in a linear combination with the entered variables is (0.923) and this indicates a high relationship between the independent and dependent variables.

The first independent variable included in the model is the economic variable that has a correlation coefficient (0.822) with the growth pattern of the studied villages. In the second step, the social dimension enters the model where the R value is (0.903) and the R2 value is jointly increased with the previous variable (0.815). In the third step, when the physical dimension variable enters the equation, the R value increased to (0.918) and the R2 value to (0.843). In the fourth step, when the last variable, the environmental dimension, enters the equation, the value of R reaches (0.923) and R2 reaches (0.852). Therefore, based on the adjusted R2 coefficient, these four variables explain (0.849) percent of the variance related to the dependent variable (growth pattern).

Table 9. Classification of Growth Patterns of Villages according to Allen Prescott Spectrum

village	mix-land use	compact development	optimal housing	walking	Attractive settlement	Environmental quality	Internal development	Transportation options	Strong social participation	Improving the local economy	Smart growth
ebrahim abad	4*	5	5	3	4	4	3	5	4	5	4
emamzade bagher	5	4	5	4	5	5	5	4	5	5	5
emame bala	5	5	5	3	5	4	4	5	4	5	5
bagh kamesh	4	5	5	3	5	4	4	5	4	5	4
chelghaz	5	4	5	3	4	4	5	5	4	5	4
rye	4	4	5	3	5	4	5	5	4	5	4
zaman abad	4	4	5	3	4	3	5	5	4	5	4
sarbandan	5	4	5	3	5	4	4	5	4	5	4
gheshlagh malard	4	4	5	4	5	4	4	5	4	5	4
abdol abad	4	4	5	4	5	4	5	5	4	5	5
ghaleno amlak	4	5	5	5	5	4	5	5	5	5	5
ghaleno chaman	4	4	5	3	5	4	5	5	4	5	4
kordzar	5	4	5	4	5	5	5	5	4	5	5
lalan	5	5	5	3	5	4	4	5	4	5	5
mehrabad	4	4	5	3	4	5	5	5	4	5	5

1.smart growth 2. Potential smart growth 3. Middle 4. Potential Sprawl growth 5. Sprawl growth

Source: Authors' studies, 2019

JSRD

Table 10. Relationships of dependent variables (growth pattern) and independent variables (elements of sustainable development)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.822a	.676	.675	.08449
2	.903b	.815	.814	.06399
3	.918c	.843	.841	.05905
4	.923d	.852	.849	.05759

a. physical b. physical, economic c. physical, economic, social d. physical, economic, social, environmental

Source: Authors' studies, 2019

JSRD

Variance analysis of regression also shows that there is a definite linear relationship between independent and dependent variables. In fact, in each model, at least one of the variables plays a role in explaining the dependent variable, which is significant at the alpha 0.05.

According to Table 11, the best model is to predict the effect of independent variables on the dependent variable of Model 4, which is as follows.

$$Y=0.134+0.541X_1+0.206X_2+0.13X_3+0.041X_4$$

The larger the (Beta) and (T) values, and the smaller (Sig) which means that the independent variable (prediction) has a stronger effect on the dependent variable. As Table 11 shows, among the dimensions of smart growth, the physical dimension with beta coefficient (0.554) had the highest influence on the growth pattern of rural areas. Then, the economic dimension with beta coefficient (0.020), social dimension with beta coefficient (0.13) and finally the environmental dimension with beta coefficient (0.041) had the highest effect on the smart growth pattern.

Therefore, based on the findings from the final model of influence coefficients of the independent variables on the dependent variable, it was found that the physical variable had the highest influence on the dependent variable (growth pattern) (Figure 2).

5. Discussion

Although the sub-urban rural areas are heavily influenced by the growth and development of cities and their relationships, this effect appears more in the form of population growth and physical expansion of rural settlements around cities which do not have the economic, social and ecological development within the framework of sustainable rural development. In the context of sustainable development theory, in recent decades, different approaches such as Healthy Village, Ecovillage, Ecological Theories, etc. have been presented and each one had their strengths and weaknesses. However, the smart growth pattern as a holistic approach was a response to the sprawl and unplanned growth of settlements. Therefore, in this study, we tried to evaluate the rural areas of around Tehran metropolis based on the smart growth model principles. It is estimated that the pattern of rural development around Tehran's metropolis is sprawl and potential sprawl.

Table 11. Stepwise Regression Coefficients to Study the Impact of Independent Variables (Economic, Physical, Social and Environmental) on Rural Growth Pattern

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.495	.062		7.916	.000
	physical	.707	.032	.822	21.782	.000
2	(Constant)	.261	.051		5.165	.000
	physical	.569	.027	.662	21.251	.000
	economic	.275	.021	.406	13.025	.000
3	(Constant)	.201	.048		4.227	.000
	physical	.537	.025	.625	21.304	.000
	economic	.227	.021	.334	10.822	.000
	social	.125	.020	.192	6.356	.000
4	(Constant)	.134	.050		2.680	.008
	physical	.541	.025	.629	21.979	.000
	economic	.206	.021	.303	9.693	.000
	social	.130	.019	.200	6.778	.000
	environmental	.041	.012	.095	3.552	.000

Source: Authors' studies, 2019

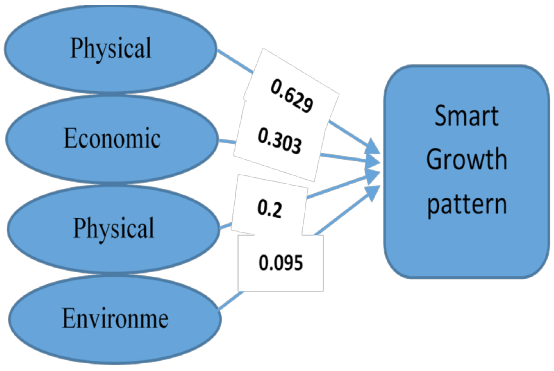

Figure 2. Coefficients of influence of independent variables on the dependent variable

JSRD

In other words, the growth patterns of the villages are sprawl growth in principal of optimal housing, attractive housing, internal development, optimal transportation and investment attraction. Villages also follow a pattern of potential sprawl growth based on the principles of mix-land use, interval development, environmental quality and social participation. Only in terms of walkable services principle do the villages have a middle smart growth pattern.

At least in the sample areas, the smart growth pattern has not taken its place as a spatial strategy in regional and local planning policies. Being affected by Tehran's metropolitan policies and programs, villages are more susceptible to change, unintentional, and sprawl growth. On the other hand, the results indicate that the smart growth model pursues sustainable development goals. However, among the principles of sustainable development, more attention is paid to its physical dimension. The results of regression analysis between the smart growth model as dependent variable and the dimensions of sustainable development as independent variable confirm this fact. Therefore, rural planners must prioritize physical and economic issues to achieve the Rural Growth Model, while not neglecting social and environmental issues, as the prerequisite for achieving sustainable development is their simultaneous attention to all dimensions. Indeed, it is not possible to accept the fact that a society does not comply with all principles, but it must be kept in mind that, wherever they are implemented, they must be in harmony with each other.

Acknowledgements

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflict of Interest

The authors declared no conflicts of interest.

References

American Planning Association (2002) Planning for smart growth: 2002 state for states[Online]. Available at: http://www.planning.org/growingsmart/pdf/states2002.pdf. Accessed 14 November 2008

André Cavalcante. S, Denilson. T, Emiliano. G and Glaucia Ap. P. (2018). Exploring the Local Sustainability Approach Using Indicators, Journal of Management and Sustainability, Vol. 8, No. 4 .

Begg,I and Larsson,A. (2005). A 'smart growth' strategy for sustainable development [Online]. Available at http://www.cer.org.uk/pdf/briefing_sustainable_begg_larsson.pdf. Accessed 26 December 2008

Burchell,R., Listokin,D., and Rutgers,G. (1999). Smart growth: more than a ghost of urban policy past, less than a bold new horizon. Housing Policy Debate 11(4) 821-877.

Burchell, R. W., D. Listokin, and C. C. Galley. (2000). Smart growth: More than a ghost of urban policy past, less than a bold new horizon. Housing Policy Debate 11 (4): 821–79.

Burchell, R. W. & Mukherji, S. (2003). Conventional development versus managed growth: The costs of sprawl. American Journal of Public Health, 93, 1534-1540.

Couroux. D, Keough. N, Miller. B, Row. J (2006). Toward Smart Growth in Calgary, A Discussion Paper Prepared for the Calgary Citizens' Forum, p: 1-32.

Daniels and Bowers (1997). Holding Our Ground: Protecting America's Farms and Farmland, Washington, D.C. Island Press, p. 11.

Daniels, T (1999). What to Do a bout, Rural Sprawl? paper present at The American Planning Association Conference, Seattle WA, April 28.

Downs, A. (2005). Smart growth: why we discuss it more than we do it. Journal of the American Planning Association. 74(4) 367-380.

Environmental Protection Agency (2008). About smart growth. Accessed at Feb Jan. 2009. Available at: http://www.epa.gov/smartgrowth/about_sg.htm#what_is_sg

Environmental Protection Agency. (2009). Smart growth. Washingto,D.C: Environmental Protection Agency. Available at:http://www.epa.gov/smartgrowth/ Accessed Feb 2009

Ghadramarzi, Hamed and Afshari, Maryam (2008). Physical Transformations of Peri-Urban Villages in the Process of Village-Urban Interaction, Case Study of Hassanabad and Nayser Sanandaj Villages, Housing Journal, No. 121, Spring 2008, Tehran. Pp. 75-64.

Halligan, D.(2000). Maryland's smart growth and neighborhood conservation initiative. institute of transportation engineers. ITE journal, 70, 36.

Hesam, Mehdi; Cheraghi, Mehdi and Ashour, Hadise (2014). Analysis of Environmental Impacts of Physical Expansion of Rural Areas, Case Study: Shahkuh Sofla Village, Housing and Rural Environment, No. 148, pp. 78-63.

ICMA .(2010). Getting to Smart Growth: 100 Policies for Implementation, meriland press.

Iran Statistical Center (2016). Detailed results of the general population census and housing.

Knapp, G. & Talen, E. (2005). Infrastructure Finance and Urban Development in Illinois: Does Negotiation Exacerbate Sprawl? In F.Ennis (Ed.), Infrastructure Provision and the Negotiating Process (pp. 155—174). Hampshire, England: Ashgate.

Levy. J (2008) Contemporary urban planning 8th edit. Upper Saddle River, NJ: Person Education

Litman, T., (2013), Understanding Smart Growth Savings, VTPI (www.vtpi.org); at www.vtpi.org/sg_save.pdf.

Mohammed. Ishak,. Alshuwaikhat. Habib M and Adenle. Yusuf A (2016) An Approach to Assess the Effectiveness of Smart Growth in Achieving Sustainable Development, Sustainability Journal, 8, 397, PP: 1-22.

Naldi. L, Nilsson. P, Westlund. H and Wixe. S (2015). What is smart rural development? Journal of Rural Studies 40 (2015), pp: 90-101.

Nelson. K (2012). Essential Smart Growth Fixes for Rural Planning, Zoning, and Development Codes, Environmental Protection Agency(EPA), available at: www.epa.gov/smartgrowth

Porter, D. (2002). Making smart growth work. Washingto,D.C.: Urban Land Institute.

Portney, K. (2003). Taking sustainable cities seriously: economic development, the environment, and quality of life in American cities. Cambridge, Massachusetts: The MIT Press.

Pourtaheri. M. (2005). Applied Statistical Analysis in Geographical Researches, Ghomes Publishing Company,P.420

Ravetz, J.; Loibl, W. (2011). The dynamics of the peri-urban: Global change and regional response. In Peri-Urbanisation in Europe: Towards European Policies to Sustain Urban-Rural Futures; Synthesis Report; PLUREL [Sixth Framework Programme]; Forest & Landscape, University of Copenhagen: Frederiksberg, Denmark, 2011.

Safari, Rojyvar (2014). Investigating the Problems of Peri-Urban Villages for Sustainable Development, National Electronic Conference on Sustainable Development in Geography and Planning, Architecture and Urban Planning, Tehran.

Smart Growth Network. (2006). Affordable housing and smart growth: making the connection. Washington, D.C.: Smart Growth Network [Online] Accessed at: http://www.smartgrowthamerica.org/affordable_housing.pdf Accessed January 12 2009

Slaev, Aleksandar D. and Nikiforov, Ivan. (2013). Factor of Urban Sprawl in Bulgaria, Spatium International review, No. 29, July 2013, pp. 22-29.

Speir, C. & Stephenson, K. (2002). Does sprawl cost us all? Journal of the American Planning Association, 68, 56—70.

Tregoning, H Agyeman, J., & Shenot, C. (2002). Sprawl, smart growth and sustainability. Local Environment 7(4) 341-347.

Walmsley, Anthony (2006) Greenways: multiplying and diversifying in the 21st century, Landscape and Urban Planning, Vol 76.WWW.SGN.org/about. (2012).

Wells. Barbara (2002). Smart growth frontier: at the frontier: Strategies and Resources for Rural Communities, Northeast-Midwest Institute, U.S. Environmental Protection Agency, Washington, DC 20003, available at: www.nemw.org

Yang, F. (2009) If "Smart" is "Sustainable"? An Analysis of Smart Growth Policies and Its Successful Practices. Master's Thesis, Iowa State University, Ames, IA, USA, (2009).

Ye, L., Mandpe, S., & Meyer, P. B. (2005). What is "smart growth?"—Really? Journal of Planning Literature, 19, 301-315.

Zamanian. R, majedi. H, shrifzadegan. M.H, kazemiyan. G.R (2015). using urban smart growth approaches in planning terms of tehran metropolis green belt, International Journal of Architecture and Urban Development Vol.5, No.4, Autumn 2015.

Zovanyi. G. (2004). A growth-management strategy for the auckland region of new zealand; pursuit of sustainability or mere growth accommodation? international journal of sustainable development. 7(2): 121-145.