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The Urban land use Planning Using Cellular Automata Model: A Case study of 1st Municipal district of Isfahan city, Iran

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Abstract

Efficient use of land and urban land use planning is one of the key issues in urban planning system and should be informed and guided by the uncontrolled growth of cities and the development of agricultural lands to prevent waste. Due to the importance and necessity of urban land use planning and discussion of the problems of modern cities. It is necessary to apply new methods and tools that can assist planners in making decisions. Among these methods, methods based on support systems are planned. One of these methods is decision support system –based methods. Cellular automata model is one of the dynamic programming methods analyzing the urban land use structure and the related effects through stimulation of urban land use and prediction of its changes. In cellular automata with a survey of the land and allocating land to land demand forecast, the future of the region is anticipated through a variety of allocation scenarios. The results show that the best decision for the area of 1th Municipal District of Isfahan City is applying the functional areas of residential neighborhoods in areas suitable for residential development and welfare activities in moderately suitable areas for residential development and it is achieved by analysis of environmental suitability stage. Also, promoting the employment to keep the original population of historical fabric of the region is considered.

Keywords: Urban land use planning, decision support system, cellular automata, 1st municipal district of Isfahan City.

Introduction

Urban issues have complex dimensions and to solve them, we should simplify and then analyze them. In the past, the mentioned phenomena were modeled. But the models were mostly static and they were less consistent with the real world[1] and they had less compatibility in terms of time and place dynamics. As we are living in a period in which changes are made immediately, and these changes are different in terms of time and place, static models can not be applied for them and it is required to use a dynamic system. As we know, urban land use has many various dimensions (physical, natural, economical, social and institutional), each with definite position in scientific analyses. Based on the tangibility of the components of the functions and the changes in physical dimension of urban land use, dynamic and observable changes of this dimension are taken into attention. The present study was done by dynamic model CA and based on theoretical basics and new approaches of urban planning (people participation, etc) optimized and predicted the various scenarios. The present study aimed to evaluate the model product ability and its main benefit for urban planning in creating efficiency of land use plans.

Extensively, urban land as rare goods is allowed to be occupied as unplanned. Thus, any action or shortcoming on land use is effective on people; business, region organizing and morphology of the city. The prediction of the effects and policy making outcome indirectly are two important factors in planning studies[2].

The urban land use planning means the optimal use of land for different urban activities and urban performances and it was the main challenge of urban and urbanization planning[3]. In urban literature of most of the countries as England, urban planning is equal to land use planning. The cities are vital organs and their growth is unavoidable. Being aware of this issue caused the major attempt to organize residential areas (developing) being formed from the past in the framework of thoughts for the city shape and some models for the growth of city[4]. The different views and research shortcomings of urban land under economical growth and technology development promoted the cities and urban population in the world generally and in third world countries specifically and now, it is turned into more challenging issue. The theorists believed that the population of the third world countries was doubled in a short time and this rapid growth had important effects on urban land supply and demand. Thus, controlling the land, the vital source of human beings with two special features (production and goods features at the same time), turned into an important issue. It can be said that formation of land use system in any urban community and dividing the land and using it in the various services are the results of mutual performance of a set of various environmental, economical, social, political and legal factors. By the growth of investment relations in the cities, land economy and value added were turned into one of the important fields of gaining capital

and serious social inequality in the cities. Also, many problems were raised in urban planning and design[5].

Cellular automation is a good framework for modeling the complex spatial processes[6]. Thus, cellular automata is consisting of simple components and produces complex behavioral models[7], this is done by predefined simple rules in the form of local decisions. Thus, the modeling the complex spatial systems based on cellular automata is more realistic. Based on the fact that a few scientific studies in this field are conducted in Iran, most of the existing researches are on other applications of CA model and there is no effective study on prediction of land use distribution by this model in Iran, the present study attempted to cover this deficit. If this model is used as decision making tool for the urban managers in future, we will have the cities with good distribution in Iran. The present study tested the following hypotheses: i. It seems that the coordination between future development of 1st municipal district of Isfahan city and urban land use planning can be possible by planning and analytic models. ii. It seems that using CA model in urban land use planning increased the accuracy of urban projects.

Material and Methods

The main aim of the present study is urban use CA models with the aim of simulating the probable changes of land use in 1st municipal district of Isfahan city.

Function 1: The rules of transition potential in CA models of land use (urban and regional CA models): $TP_{T+1} = F(S_T,NB,AC,SU)$, TPt+1 = transition potential of tested cell at time t+1, St = tested cell state at time t, NB = the neighborhood effect, AC = accessibility effect, SU = suitability effect.

The numerical data and their conversion to matrix and special algorithms were done by most of the software and programming languages. This stage was done by ToolBox of ArcGIS software.

The applied data of the study The resources in the present study are two types: i. Spatial data, ii. Descriptive data.

In defining the spatial data, we can say that the data are defined by X, Y coordination on earth. The descriptive data is the one collected via library resources, statistics and field observation, etc.

The spatial data in the present study are: i. Numerical map 1:1000 detailed plan of Isfahan, ii. Numerical map 1:1000 existing condition in Isfahan city, iii. Numerical map of the statistical blocks of housing statistics in 1996, 2006 from Iran statistics center. iv. Land use map of 1st municipal district of Isfahan city during 1996, 2006.

The descriptive data was: i. Statistical study of Iran statistics center in 2006. ii. Isfahan plan 1996 by Isfahan Municipality, iii. Detailed plan review of Isfahan 2007 by Isfahan Municipality, iv. Detailed plan of Isfahan 1992 by Paris Naqsh Jahan consultant, v. Statistics of Isfahan city 2011.

Results and Discussion

Structural-activity analysis method was used. The evaluation of the problems of decision making structure and the strategies of the existing plans were performed by various organizations. The evaluation of the compatibility and incompatibility of different land use was done by ArcGIS and social analysis of the regions was also performed for identification of the area.

The analysis of spatial structure of 1st municipal district based on social structure theory was done in four stages. In the first stage, the characteristics of the activity representatives (people and household, public welfare institutions and production-service institutions). In this stage, the characteristic of any manufacturing factor of activity contingent upon its features is investigated in detail. In the second stage, the characteristics of the space including residential activities, welfare activities and production-service activities in the form of area, quality of the buildings, life of the buildings, etc were evaluated. In the third stage, the type of mutual communication in the form of the number of transported passengers in the region is evaluated. In the fourth stage, the activity and mutual relation of the activity are evaluated in the form of different kinds of density. Finally, the analysis of spatial structure of 1st district is analyzed in the form of information needs of urban activity systems. It can be said that three items of time, space, structure and mutual relations among them considered.

The study of population characteristics: The study of population characteristics of 1st district showed that in accordance with housing statistics (2006) were 73926 people living in an area of 810 hectare. The changes of population growth in this region showed the positive growth of population during 1996-2006.

Household dimension in 1st municipal district was 3.5 and the number of existing households in this district was 25980 , it is lower than the mean of Isfahan city (Detailed plan review, 2008:5). The study of the age composition of the population in 1st municipal district showed that the mean age of population was 33 years. The literacy of men and women in 1st municipal district was in good level (table 1).

Table-1
The investigation of literacy in 1st municipal district

District 1	Literate			Illiterate		
	Total	**Man**	**Woman**	**Total**	**Man**	**Woman**
	63866	32335	31531	5314	1690	3624

The study of the economical characteristics: During 1996-2006, the population of residents above 10 years was increased rapidly in 1st municipal district and historical monuments areas in Isfahan. The investigation of employment in 1st municipal district showed that more than half of the active population was employed. Employment rate in this district can prove this issue.

Thus, the increase of activists group in 1st municipal district was mostly focused on employed section.

The second step to analyze the spatial structure of 1st municipal district is the study of the characteristics of the related activities. These characteristics can be analyzed in terms of area, possession, building quality, building age and etc.

The total area of residential use in 1st municipal district was 5398855 m^2 in accordance with the development plan studies of Isfahan. By the investigations, most of the residential buildings in 1st municipal district were built of durable construction materials. Only about 29% of them applied unstable materials. Most of the residential buildings in 1st municipal district had the minimum facilities for each residential unit.

The environments including public welfare activities many include educational, sport and remedial areas. The area of educational spaces (210051), sport (32827), religious (77020), Remedial (87645) and library (912) m^2. The quality evaluating of land use in 1st municipal district of Isfahan city.

In quality evaluation of 1st municipal district, they are compared with each other and to the surrounding environment based on compatibility matrix in order to evaluate quality characteristics of the land use in terms of compatibility by Matrix table (table 2). The land use in the same influence field should be consistent in terms of activity and they shouldn't disturb the related activities. It is possible that the land use has the following states in terms of compatibility. i. Completely compatible with each other. It means that both of them have common characteristics and their activities are consistent. Like two low-density housing. ii. Relatively compatible, generally they belong to one group but they have some differences in terms of details such as low-density housing and moderate-density housing. iii. Indifferent, it means that each has the specific characteristics and no problem is occurred as they are beside each other or not. iv. Relatively incompatible, it means that incompatibility between two land use is more than their compatibility. v. Completely incompatible, it means that the characteristics of two land use are not consistent and they are opposite to each other.

The related scenarios of modification of thee problems are obtained by CA model transition rules and the proposed maps were created for good distribution of the use in 1st municipal district of Isfahan city in order to be used as a solution for the urban experts.

Table-2
The matrix of compatibility of land use

5	Completely compatible (important relation)
4	Relatively compatible
3	Indifferent
2	Relatively incompatible
1	Incompatible No relation)

	Residential	Commercial	Educational	Religious	Remedial	Administrative-security	Cultural and sport	Critical facilities (urban installations and water passage)	Industrial and workshop	Recreational (parks and green space)	Open space (unused land)	Transportation network
Residential	5											
Commercial	5	5										
Educational	5	5	5									
Religious	5	4	4	5								
Remedial	4	2	5	5	5							
Administrative-security	3	3	2	3	5	5						
Cultural and sport	4	3	5	2	3	3	5					
Critical facilities (urban installations and water passage)	2	2	3	2	2	2	1	5				
Industrial and workshop	2	2	2	1	1	2	2	1	5			
Recreational (parks and green space)	5	3	5	3	3	3	5	1	2	5		
Open space (unused land)	5	5	5	5	5	5	5	5	5	5	5	
Transportation network	5	3	4	5	4	5	5	5	5	5	5	5

The study and analysis for renovation and revitalization in district 1 municipality of Isfahan city: To classify the districts, required measurements should be taken in district 1 municipality of Isfahan city as three groups: a. refinement, b. renovation and empowerment, c. requiring security. Some criteria are determined for simple and complex forms of worn-out areas. These criteria based on their special definition and available information is selected and then they are sent for audit and then the built spaces at urban block are classified based on urban wear-out areas.

Determining the criteria and classification of worn-out areas: The only existing criteria in simple form of worn-out area is the building wear-out and complex form criteria of urban wear-out including incompatible use are the unpractical model of the roads and land at urban block scale.

The constraints of determining the districts requiring treatment in the district: District 1 municipality of Isfahan city has valuable monuments and they should be considered in the districts requiring renovation and re-development. Based on wear-out criteria, these areas were determined in need of revitalization and they can not be destroyed and they should be introduced as the districts in need of revitalization and renovation.

Determining the simple form of wear-out in the district: This form of wear-out is divided into structural criteria of urban space and surrounding environment criteria and based on available information, only the buildings wear-out is a structural criterion of urban space and it can be evaluated.

The wear-out criteria of the buildings: The buildings in terms of wear-out are classified into four types of stable, repairable, under construction and worn-out. Any building is investigated based on its location in four conditions of building worn-out in each urban block. Any urban block in district 1 municipality of Isfahan city is scored in three groups.

The presence of impractical model of roads network: In this stage, scores 1 to 3 were considered for the blocks of district 1 municipality of Isfahan city. Score 1 is dedicated to the blocks without or a few rider access. Score 2 is dedicated to the blocks in the region in which the number of blocks without any rider access land use is less than 50% of the number of land use. Score 3 is dedicated to the blocks in the region in which the number of blocks without any rider access is more than 50% of the number of land use of the block.

The criteria of impractical model of land: According to this criterion, for urban blocks, pieces of land with the area of less than $200m^2$ is not used and the areas under $100m^2$ as prevalent in district 1 municipality of Isfahan city, made the impractical model for land portioning as challenging. Based on the scoring to the blocks in district 1 municipality of Isfahan city, three scores are dedicated. Score 1 is dedicated to the blocks in which there is no land with the area of less than 100m and there is little land with the area of below $200m^2$. Score 2 is dedicated to the blocks in which the areas under $100,200m^2$ were less than 50% of pieces of land in that block. Score 3 was dedicated to the blocks in which the pieces of land for the areas under 100,200 m^2 was high and they were more than 50% of the number of blocks.

The results of environmental suitability analysis for residential re-development in district 1: For environmental suitability analysis of the areas that are determined for residential renovation, the criteria access, neighborhood and environmental quality were considered. Based on the analyses, 171.9 hectare of the districts was considered as the appropriate areas for development.

The results of estimation of the need to space in district 1: Based on the analyses of the previous sections, it can be said that to provide 7387 required residential units for the resident population added to the district in plan horizon year, the increase of residential density of average 200 people per hectare for total district was proposed for entire district and the required area to provide the housing of the district is 59.34 hectare. By the increase of district density to the standard values, total extra area of supply/demand was 112.56 hectare that is used for reserving urban land to meet the demands of the district.

The initial prescription of land use alternative scenarios: Based on the final hypotheses and purposes and the results of final analysis of environment suitability and various compositions for land use, the initial scenario of land use in appropriate areas of renovation 1^{st} district of Isfahan city is prescribed. 3 scenarios of land use are achieved (figure 1). The production of initial scenarios is based on residential, public welfare activities, production-service activities.

Allocation operation of the use is continued until the required per capita of master and detailed plan is provided. The conditions of 3 scenarios are as:

First scenario: i. IF tested cell under consideration is Residential, then change it to residential if there is test cell in appropriate areas. ii. IF tested cell under consideration is educational or cultural or religious or remedial or administrative or recreational, then change it to educational or cultural areas or religious or remedial or administrative or recreational areas if there is test cell in moderately suitable areas (until providing per capita). iii. IF, after the latter condition was imposed and again a blank area of the region remained moderately suitable areas, change with priority order to commercial land use; transport land use; critical facilities land use; workshop land use (until providing per capita).

Second scenario: i. IF tested cell under consideration is Residential, then change it to residential if there is test cell in appropriate areas or moderately suitable Areas. iii. IF tested cell

under consideration is commercial or transport or critical facilities or workshop, then change it to commercial or transport or critical facilities or workshop if there is test cell in appropriate areas or moderately suitable areas (until providing per capita). iii. IF tested cell under consideration is residential or educational or cultural or religious or remedial or administrative or recreational, then change it to before land use if there is test cell in appropriate areas (until providing per capita).

Third scenario: i. IF tested cell under consideration is residential or educational or cultural or religious or remedial or administrative or recreational, then change it to residential or educational or cultural areas, religious, remedial, administrative, or recreational areas if there is test cell in appropriate areas (until providing per capita). ii. IF tested cell under consideration is residential, then change it to residential if there is test cell in moderately suitable areas. iii. IF tested cell under consideration is commercial or transport or critical facilities or workshop, then change it to commercial or transport or critical facilities or workshop if there is test cell in appropriate areas or moderately suitable areas (until providing per capita).

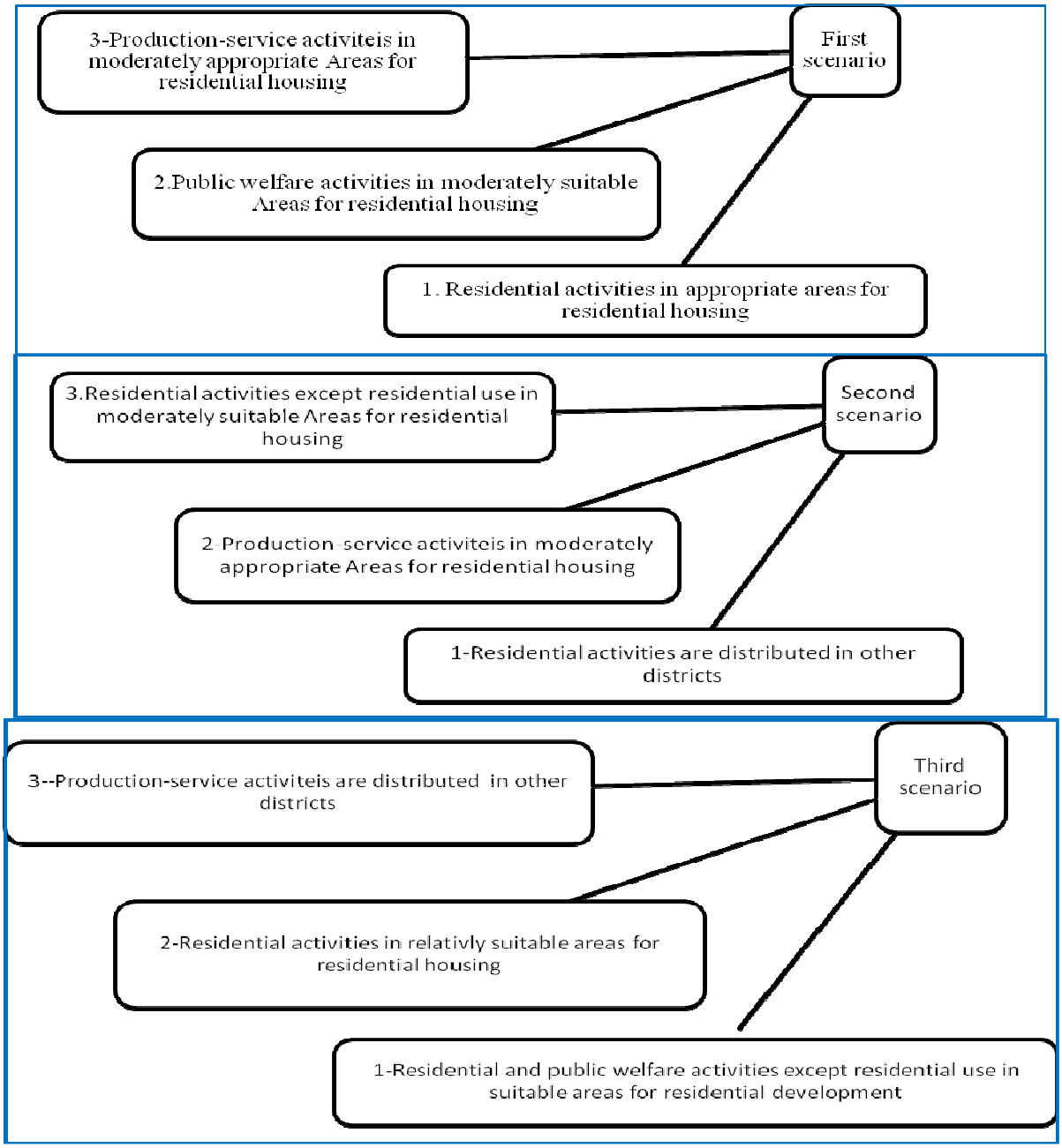

Figure-1
Three scenarios of allocation method of land use

By some conditions for each of the scenarios, the final map was considered for each scenarios (figures 2,3,4). It can be said that in the scenarios, if the required space is not provided by plan conditions, it is required to use open and unused space being in different regions from the analytic regions (tables 3,4,5).

It is possible that in the next 10 years (2016), the conditions are changed and they are not in accordance with the prediction, thus, the required space for the shortage of the areas being computed in each scenario by software are obtained based on the condition and comments of urban managers, required space among the existing unused land. Thus, in allocation plan, the spaces were given to urban manager.

Table-3
The results of the required areas by applying the first scenario

	First scenario				
	Existing area (hectare) based on population 2006	**Per capita of land use in 2006**	**Required area (hectare) for horizon year 2016**	**Final area (hectare)**	**Final per capita**
Residential	396.1	53.58	45	441	49
Commercial	29.5	3.99	5.5	36	4
Administrative	6.7	0.91	5	11.7	1.29
Educational	18.5	2.50	25	43.5	4.8
Workshop	12.4	1.68	1.6	14	1.55
Religious	6.9	0.93	2.1	9	1
Remedial	7.8	1.06	7.2	15	1.66
Cultural, sport, office services and social	11.8	1.59	22	33.8	3.7
Transportation	3.1	0.42	4	7.1	0.78
Communication networks	167.7	22.68	52	219.7	24.37
Critical installations	9.1	1.23	6	15.1	1.67
Recreational (tourism, reception, vegetation)	24.8	3.35	10	34.8	3.86
Unused (open space, abandoned area)	68.4	9.25	_	18	_

Table-4
The results of required area by applying the second scenario

	Second scenario				
	Existing area (hectare) based on population 2006	**Per capita of land use in 2006**	**Required area (hectare) for horizon year 2016**	**Final area (hectare)**	**Final per capita**
Residential	396.1	53.58	53.90	450	49.93
Commercial	29.5	3.99	22.5	52	5.77
Administrative	6.7	0.91	5	11.7	1.29
Educational	18.5	2.50	10	28.5	4.8
Workshop	12.4	1.68	2.6	15	1.55
Religious	6.9	0.93	2.1	9	1
Remedial	7.8	1.06	7.2	15	1.66
Cultural, sport, office services and social	11.8	1.59	8.2	20	2.21
Transportation	3.1	0.42	15	18.1	2
Communication networks	167.7	22.68	52	219.7	24.37
Critical installations	9.1	1.23	14	23.1	2.56
Recreational (tourism, reception, vegetation)	24.8	3.35	11.2	36	3.99
Unused (open space, abandoned area)	68.4	9.25	_	18	_

Table-5
The results of required area by applying the third scenario

	Third scenario				
	Existing area (hectare) based on population 2006	**Per capita of land use in 2006**	**Required area (hectare) for horizon year 2016**	**Final area (hectare)**	**Final per capita**
Residential	396.1	53.58	53.90	450	49.93
Commercial	29.5	3.99	15	44.5	4.93
Administrative	6.7	0.91	10	11.7	1.29
Educational	18.5	2.50	24	42.5	4.71
Workshop	12.4	1.68	2.6	15	1.55
Religious	6.9	0.93	3.1	10	1.10
Remedial	7.8	1.06	13.2	21	2.33
Cultural, sport, office and social services	11.8	1.59	13.2	25	2.77
Transportation	3.1	0.42	4.3	7.4	0.82
Communication networks	167.7	22.68	56.3	224	24.85
Critical installations	9.1	1.23	18	27.1	3
Recreational (tourism, reception, vegetation)	24.8	3.35	30	54.8	6.08
Unused (open space, abandoned area)	68.4	9.25	_	18	_

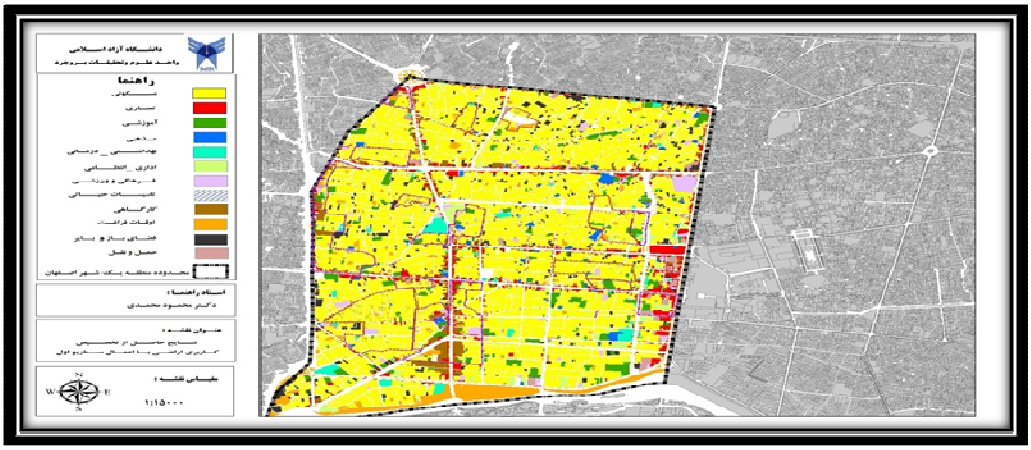

Figure-2
The proposed map of analysis by CA model for first scenario

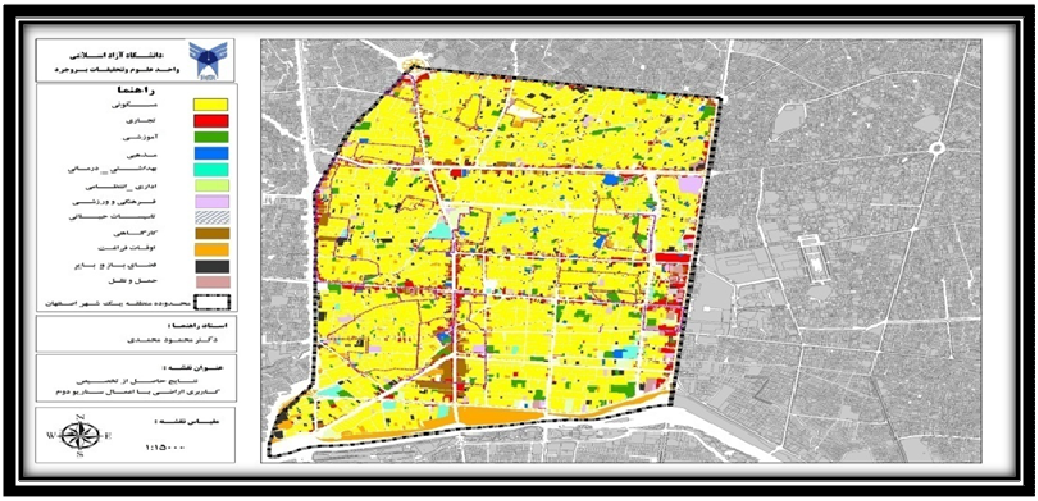

Figure-3
The proposed map of analysis by CA model for second scenario

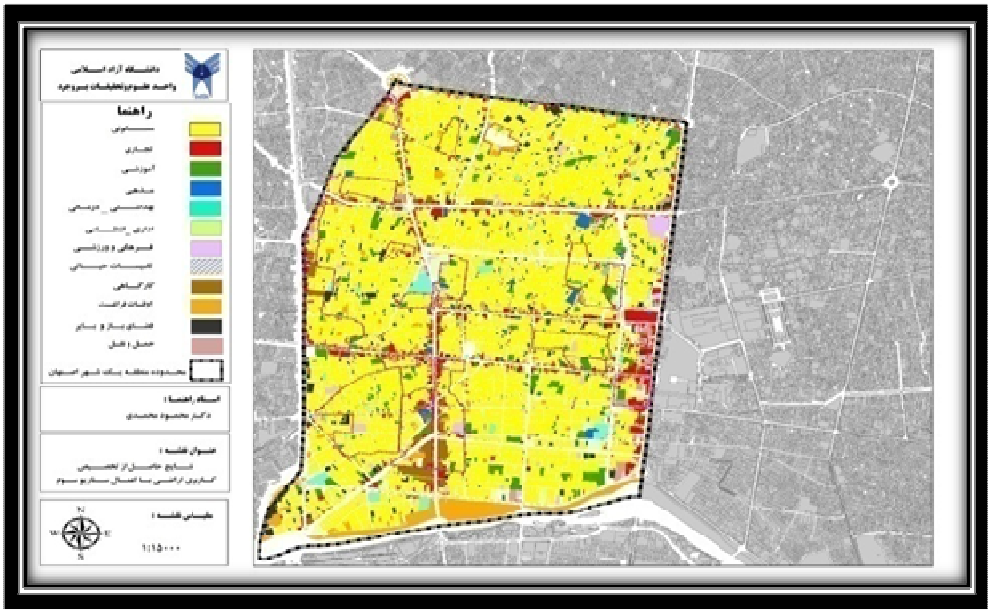

Figure-4
The proposed map of analysis by CA model for third scenario

Discussion: The present study aimed to combine cellular automata with analytic software with applied planning approach of urban land use. Based on the results of the study, some of the capabilities of the model are tested and positive results were achieved. Two hypotheses were raised as:

First hypothesis: It seems that coordination of future development of District 1 municipality of Isfahan city and planning of urban land use are possible via planning and analytical models.

To evaluate the land use of District 1 municipality of Isfahan city, the existing standard per capita index and detailed plan of Isfahan was used. Based on the investigations about the shortage of urban us and by ArcGIS software, the appropriate areas for residential development and relatively suitable areas for residential development and appropriate areas for service, welfare use and unsuitable areas were defined and by implementation of CA, we could use all the factors for implementation of scenarios and coordinate the planning process of urban land use for further development of city by presenting a strategic plan. Based on the mentioned items, hypothesis 1 is supported.

Second hypothesis: It seems that using CA model in urban land use planning increased the accuracy of urban projects.

To test the hypothesis, the data, information and study area maps were divided into two periods 1996, 2006 and each showed the land use condition of the year. Then, cellular automata rules were formulated on the first type (information of map 1996). Regarding the natural phenomena, most of the analyses were based on the weight of environmental potential for city development and various methods based on natural phenomena mechanism were used. Finally raster layers (simulated raster layer in 2006 and real raster layer in 2006) were compared by pixel to pixel. The results showed that the city development in the study area is consistent with the reality as 96% and the results of this software are reliable and this increases the accuracy of urban land planning.

The initial scenarios of land use alternative should be recommended based on the hypotheses that can help in production of the final statement of the hypotheses. Three scenarios were presented that can be used in design stage of strategic plan.

The production of final statement of vision of strategic plan of 1th Municipal District of Isfahan City changes: This section deals with the formulation of vision of change and development of District 1 municipality of Isfahan city. The existing vision of Isfahan as documents is reviewed. Isfahan plan 2035 didn't have any vision. The four plans provided by Isfahan Municipality were provided as Isfahan plan 22, Isfahan 2006, Isfahan 2011, Isfahan 2016 in accordance with Isfahan vision 2025.

The production and modification of the final statement of development and change goals of 1th Municipal District of Isfahan City Based on the goals of various paths including the goals of problems, the existing plan goals, space estimation goals and environmental suitability relation and final map considered by the analyses of three scenarios, summery of the goals and production of final statement of planning goals of 1th Municipal District of Isfahan City are shown in table 6.

Table-6
Final statement of strategic plan goals of development and change of 1th Municipal District of Isfahan City

Field	Macro classification	Micro classification	Vision
Activity systems	Intra-spatial	People and household	- Improving the life quality of citizens - The development of residential areas in renovated land in this district and based on environmental suitability relation - Renovation of township structure - Improving the social link of citizens - Renovation of distressed areas - Increasing the safety of townships
		Public welfare institutions	- Protection, renovation and optimal use of environment - Development of township, regional and district green space - Distribution of public and welfare services to improve the satisfaction of the residents and users - Increasing the efficiency of urban infrastructures - Increasing social security
		Production-service	- Refinement of activities in terms of activities and performance consistency for good distribution of the activities - Creating productive employment with emphasis on required services of urban environment vitality - playing the role of transregional with emphasis on support activities-tourism services - Transregional role of specialized remedial services
	Inter-spatial	Energy	
		Goods and human beings	- Easy and integrated development of urban transportation with emphasis on transportation - Improving the condition of passages and rider and pedestrian movements - Renovation of Madi network
		Information	- Creating data bank in the region
Decision making structure			- Movement toward fulfillment of integrated urban management

The introduction of strategic plan of change and development of 1th Municipal District of Isfahan City with emphasis on urban land use: In this plan, the general fields of change and development are presented to determine the executional framework in the next stages. The strategic plan of change and development of 1th Municipal District of Isfahan City is introduced with the approach of land use planning with three scenarios in this plan.

Strategic plan of development of 1th Municipal District of Isfahan City: Using strategic development plan of 1th Municipal District of Isfahan City as the result of combining output maps of three scenarios with cellular automata were presented in the following 5 strategic locations: i. The development of functional areas of residential township: In the land in the stage of environmental suitability analysis appropriate for residential development and in the regions outside of monuments of Isfahan. In the regions in this border, the improvement of housing condition is done based on the regulations. ii. Development of employment: To keep the original population of historical fabric of the region and reduction of migration to outside the region by providing the employment of the residents in the region. iii. The development of welfare services activities: in the less suitable land of environmental suitability analysis to improve the satisfaction of the residents and users with compensating the existing welfare services activities and providing the future need. iv. The development of functional recreational areas: Including local green spaces, regional. This strategy is in accordance with best alternative based on development of functional recreational areas and improving the quality of environment. v. Development of IT: By e-working and reduction of traffic in the cities, improving the quality of environment and increase of employment and data bank in the region in urban management (figure 5)

Figure-5
The strategic development plan of district 1 with land use planning approach

Conclusion

Based on the studies, CA can well be used in social and economical aspects of city and it can cover the physical, social, economical simulation aspects and it is unique method compared to other models. It is more efficient due to its coordinate in spatial analyses in accordance with the data of real world.

The system entrance variables in two areas of data, information and natural environment maps entered the system. Then cellular network was weighted based on the role of natural variables in city development. All data were considered constant. Implementation of model CA was different based on the role and weight of the mentioned variables. To achieve the general result based on the existing data, the results of simulation of city development showed that if we want to achieve the selected scenarios of region analysis, during the future years, 2025, turn the zoning of the region based on the output of the maps of software.

The definition of CA rules makes the urban land use more complex than the natural environment data. Because the indices follow standard criteria. For simplicity, some of the data as important had some codes and during the implementation of CA, the changes were applied. The results of theoretical and practical studies showed that CA models based on study hypotheses can presented various capabilities to improve the planning goals of urban land use in physical aspects. One of the important findings of this study is deep consideration of theoretical issues and efficiency of the presented system and its comprehensibility based on different dimensions of urban planning and software, present and future hardware infrastructures and reduction of the weakness of the previous systems as it can have various benefits for urban planning.

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