American Journal of Environmental Sciences 5 (3): 427-433, 2009
ISSN 1553-345X

An Investigation of Sustainable Development in Urban Neighborhoods Using Statistical Models

Sedigheh Lotfi
Department of Geography and Urban Planning,
Faculty of Humanities and Social Sciences, University of Mazandaran, Babolsar, Iran

Abstract: Problem statement: Sustainable has a close relation to the quality of life in the different parts of each city. While the level of sustainability is studied in many urban areas world wide but it has been less considered in the Iranian cities. The city of Babolsar is selected to investigate the level of development by detail study of its 16 neighborhoods. **Approach:** The quantitative models such as Human Development Index (HDI), standard deviation, variable coefficient, factor analysis and the composed multiple regression (Enter) were used to assessing the level of sustainability, analyzing disparities and then to prioritize development by selecting of 30 socio-economic and physical variables. **Results:** The results from integrated indicators revealed that the sustainability coefficient was different in 16 neighborhoods of the city. The level of sustainability was classified in five categories, which only three neighborhoods were sustainable while others remained unbalanced. Also the research showed that there was a sharp disparity among the different neighborhoods of the city. The disparity mainly was evident in the environmental and social indicators with 0.98 and had been lower in the infrastructure with 0.32. **Conclusion:** By analyzing the results it could be concluded that there was a strong need for implementing long and short term planning strategies through taking different action to decrease the social and economic gap among the different neighborhoods of the city.

Key words: sustainable development, multiple regression model, neighborhood, factor analysis

INTRODUCTION

Growing concern for the future of cities and for the well-being of city dwellers, stimulated by trend in world urbanization, the increasing number and size of cities and the deterioration of many urban environments, has focused attention on the problems of living in the city[11]. As we enter the 21th century it is estimated that slightly more than 50% of the population is urban. The urban population will account for more than 60% of the world's population in 2010[8]. Such rapid growth would impact the most of urban residents who experiencing many environmental and physical crises[12].

The scenario is more complicated in developing world where the pause of urbanization seems to be incontrollable in response to different socio-economic and political transitions. Here poverty, environmental degradation, lacks of appropriate shelter burden the daily life of the urban residents[3].

The sustainable approach gained attention by the alarming condition of the urban environment and the public quality of life in the end of 20th century. Urban sustainable development is a multi-dimensional phenomenon and is not simply about creating wealth and protecting the environment. It is also about caring people and their quality of life[2,4]. So, different aspects should be considered in the study of sustainable development which covers wide social, economic, physical and environmental issues. The desire to improve the quality of life in a particular place or for a particular group is an important focus of attention for planners[6]. Following the call of Ward sustainable development became a familiar term which was supported by Brantland commission and the UN's Earth Summit in 1992[13] The conference of 1992 of Earth Summit created an environmental insight and the agenda 21 was the most important outcome of the conference. The urban comprehensive of sustainable development plan was implemented in Brazil. The plan paid attention to the issues which are included the physical growth of the city, decreasing density in the city center, enhancement of economic activities and basic infrastructures and finally development of public services[9].

The urban development plans are the main director of city planning which only recently paid attention to sustainable issue. But most of the plans are unable to realize the instruction on the defined goals due to the weakness of legal backup and financial shortages[7].

Also there is not a hierarchical relation between the comprehensive national and local plans. The present study tried by using statistical models to assess the level of sustainability with respect to 30 indicators which were mainly collected from the national census and the city municipal department.

MATERIALS AND METHODS

The city of Babolsar is the administrative center of Babolsar Township in the southern part of the Caspian Sea with an area of 1350 ha. The city had a population of 58000 in 2008 which are distributed in the 16 neighborhoods (Fig. 1). Economically, the city is located in rich agricultural hinterlands and also favors an attractive coastal area which offered a tourism opportunity combined with the educational function as the only state owned university of the province is located here. Such diversity of the economic activities attracted different social classes who resided in the neighborhoods coincide with their socio-economic status. The present study intended to assess and determine the level of sustainability of different neighborhoods by using statistical techniques and then illustrate the results spatially. The research has selected 30 different socio-economic, physical and environmental indicators to apply factor analysis and then integrate the given indicators using Human Development Index (HDI) and Coefficient Variable (CV). Finally to determine the development priority the multi-regression was used.

Testing sustainability of the neighborhoods: Today acknowledging the threats and weaknesses of urban neighborhoods is an important necessity for planning. Using the socio-economic, physical indicators could be proper criteria for determining the position of the neighborhoods and also to prevent or alleviate the problems to attain socio-economic health and sustainable development. So, urban sustainable development planning addresses the appropriate distribution of the urban land uses and intends to create a right interaction among them[5]. To determining the level of sustainability in the city of Babolsar (16 neighborhoods) 30 indicators were selected with respect to their importance and limitation of collection (Table 1).

The indicators were factorialized by applying factor analysis and analytical model of R. The indicators which had internal relation usually prefer to cumulate around a factor, so the indicators with more than 50% correlation consist a factor and the indicators with negative correlation have no potential of aggregation, so they form another factor. The factors extracted from the correlation matrix. By following the process through Varimax rotation only 6 factors remained from 30 indicators. The sums of 6 cumulative factors are able to cover the 78.7% of the variance which the share of first factor is 15.70% and the share of last one is 10.20%. It is possible to select a suitable title for each factor as Table 2, by considering the percent of correlation for each indicator.

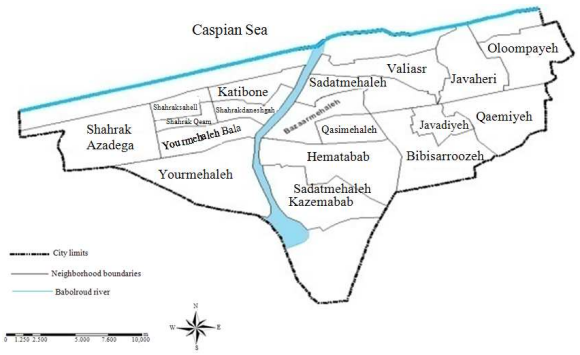

Fig. 1: The neighborhoods of Babolsar

Table 1: The different indexes to measuring the neighborhood sustainability level

No	Index
1	Percentage of litrated
2	Percentage with higher education
3	Avarge of shool duration
4	Mean of residency
5	Percentage of in-migration
6	Percentage of employed in prodction
7	Percentage of employed in agriculture
8	Percentage of employed in specialized skills
9	Mean of household monthly income
10	Inverse household monthly income
11	Percentage of inverse tanat households
12	Percentage of household with owned building and it land
13	Percentage of household with owned building
14	Percentage of household with telephone
15	Percentage household with cooler
16	Percentage houses with electerisities
17	Percentage houses with indepened kitchen
18	Percentage houses with bath
19	Percentage houses with drinking ater
20	Percentage houses with central heating
21	Inverse percentage of houses two rooms
22	Percentage of residential units with one household
23	Inverse percent of residential units with two or more households
24	Average area of residential plot
25	Average area of residential unit
26	Percentage of one unit residential building
27	Percentage of apartment building
28	Percentage of durated residential building
29	Inverse percentage of less durable residential building
30	Inverse percentage of none-durable residential building

Sorce: Mohid consulting engineers, 2002

Table 2: Final scores of different factors

Title	Specific quantity	Percent of variance	Percent of cumulative variance
Socio-environmental	5.49	15.70	15.70
Infrastructural	5.21	14.89	30.59
Physical-economic	5.15	14.73	45.32
Physical	4.19	11.99	57.31
Environmental-economic	3.90	11.16	68.47
Socio-economic	3.57	10.20	78.67

Source: Calculated by the authors

To determine the sustainability level of the different neighborhoods the results were classified in five classes as; ideal, strong, semi-sustain, weak and unsustainable.

Level of sustainability by Socio-environmental, infrastructural and physical-economic factors: the first is socio-environmental factor and include seven indicators such as the mean of curriculum years, the average area of residential units, the percentage of population with higher education, percent of households with cooler, the average area of residential plot and the percent of litrated people. The outcome revealed that three neighborhoods of 3, 8 and 15 (Shahrak Daneshgah, Kazemadad, Valiasr) were sustainable and the neighborhoods of 13, 14 and 7 (Bebesarrooze, Javadiyeh and Azadegan) have been unsustainable.

By examining the spatial distribution of the sustainability with respect to the first factor it is apparent that these neighborhoods constituted from academic and higher educated families. The residential ratio and renewed buildings is high. While the unsustainable areas are located in the older parts of the city, where the most of the families have a low income and so are not able to upgrade their housing. The women are less educated which seems such condition kept the natural birth rate higher compared to the richer neighborhoods.

The semi-sustainable neighborhoods are the areas where live middle income families and have lesser access to educational, cultural and standard housing. However their condition is better compared to the unsustainable areas. The dispersion coefficient for socio-environmental indicators has been 0.98 which shows the highest dispersion coefficient among all factors and in fact indicating the inappropriate status of these neighborhoods.

The second factor is structural and is gauged by five indicators which include the percent of families with electricity, independent kitchen, bathroom and central heating. The neighborhoods of Kazemabad and Bazaar-mahalleh (8 and 11) which consist 12.5% of the city's areas are as sustainable neighborhoods and Szadegan shahrak is the most unsustainable one.

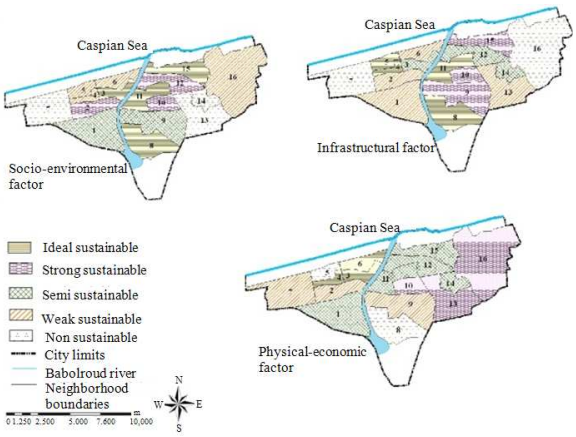

Fig. 2: Spatial distribution of sustainability (different factors)

With respect to the second factor, neighborhoods located in the margin of the city suffer from unsuitable infrastructure; and even some parts of these neighborhoods have no primary physical services as the local urban authorities do not have responsibility to provide such services as these areas are out of city's legal limits. Also these neighborhoods placed in remote areas where service provision is difficult and cost consuming and as a result the residents of these areas have a lower urban quality of life. Figure 2 shows inequality of Babosar's neighborhoods by moving from central parts towards the city periphery.

The third factor titled as physical-economic which includes six indicators. They are the percent of single residential unit, percent of apartment building, percent of durable residential building, percent of households owned their building and its area, percent of the owned buildings and the percent of employed population. According to the Table 3 the neighborhoods of Sharak Daneshgah, shahrak qaem and katibon (3, 4 and 6) are sustainable and 27hektari sharak saheli and Kazemabad (5 and 8) are the most unsustainable areas. The different neighborhoods of Babolsar show a considerable level of disparity with respect to the physic-economic factors as the dispersion coefficient is 0.79.

Level of sustainability by Socio- economic, environmental and physical-factors: Considering to the fourth factor (environmental) three indicators such as inverse percent of two bed-room residential units, percent of employed population in the agricultural sector and inverse less durable residential units were determined. According to the obtained results the neighborhood of 27 hektari of shahrak saheli showed the highest level of sustainability and Qaemiyeh,

Table 3: The level of sustainability in the neighborhoods of Babolsar

	First factor (socio-environmental)			Second factor (Infrasturactural)			Third factor (Economoc- physical)		
Neighborhoods	Score	Type	Rank	Score	Type	Rank	Score	Type	Rank
1	-0.096	Semi	9	-0.407	Weak	14	0.125	Semi	11
2	0.416	Strong	5	-0.069	Weak	11	-0.359	Weak	12
3	1.488	Ideal	1	0.251	Semi	9	0.888	Ideal	1
4	-0.364	Weak	12	0.738	Ideal	1	0.835	Ideal	2
5	-0.194	weak-	10	0.718	Ideal	4	-3.292	Unsustain	16
6	-0.398	Weak	13	-0.092	Weak	12	0.695	Ideal	3
7	-1.221	Unsustain	14	-3.221	Unsustain	16	-0.588	Weak	14
8	1.316	Ideal	2	0.725	Ideal	3	-0527.000	Unsustain	15
9	0.088	Semi	8	0.491	Strong	6	-0.367	Weak	13
10	0.310	Strong	7	0.574	Strong	5	0.499	Strong	5
11	0.798	Ideal	4	0.730	Ideal	2	0.247	Semi	8
12	0.368	Strong	6	0.200	Semi	10	0.327	Semi	7
13	-2.138	Unsustain	16	-0.340	Weak	13	0.482	strong	6
14	-1.377	Unsustain	15	0.309	Semi	8	0.299	Semi	9
15	1.312	Ideal	3	0.439	Strong	7	0.164	Semi	10
16	-.205	Weak	11	-1.091	Unsustain	15	0.642	Strong	4

Source: Calculated by the researchers

Table 4: The level of sustainability by socio-economic, physical and environmental factors

	Fourth factors (physical)			Fifth factors (environmental-economic)			Sixth factors (socio-economic)		
Neighborhoods	Score	Type	Rank	Score	Type	Rank	Score	Type	Rank
1	0.293	Semi	8	-0.163	Weak	10	2.260	Ideal	1
2	-0.299	Weak	12	0.980	Ideal	3	0.161	Semi	6
3	0.840	Ideal	2	2.397	Ideal	1	-0.681	Weak	13
4	0.690	Strong	4	1.416	Ideal	2	0.126	Semi	7
5	1.014	Ideal	1	0.661	Strong	4	-0.997	Insustain	15
6	0.580	Strong	5	-0.943	Unsustain	13	-0.623	weak	12
7	-0.990	Insustain	15	-1.066	Insustain	14	-0.886	Insustain	14
8	0.546	Strong	6	-0.838	Insustain	12	1.026	Ideal	3
9	0.167	Semi	10	-0.113	Weak	9	1.082	Ideal	2
10	-0.278	Weak	11	-1.113	Insustain	15	0.997	Ideal	4
11	-0.577	Weak	14	0.097	Semi	7	0.776	Strong	5
12	-0.355	Weak	13	-0.309	Weak	11	-0.158	Semi	8
13	0.296	Semi	7	-0.047	Weak	8	-0.300	Weak	9
14	0.276	Semi	9	0.132	Semi	6	-0.513	Weak	11
15	0.831	Ideal	3	-1.279	Insustain	16	-0.327	Weak	10
16	-3.133	Insustain	16	0.207	Semi	5	-1.542	Insustain	16

Source: Calculated by the researchers

Javaheri and Oloompayeh had the lowest level. By having a glance o Fig. 3 it is obvious that the sustained neighborhood is located in the north and north-west of the city and by approaching the center and periphery the level of sustainability decreases sharply. The population density is high which usually two or more households live in these units. The building materials are mainly substandard and illegal housing is prevailed in the unsustainable areas. To bar-coding the fifth factor (environmental-economic) six indicators were used which indicate the economic and environmental situation of the neighborhoods. According to the Table 4 Sharak Daneshgah and Valiasr neighborhoods showed the lowest level of sustainability. But the areas which are located in the north and North West have better condition as these areas housed many highly educated households and are the salary earner of the public sectors. However it needs to be mentioned that there is a meaningful relation between the economic and the environmental condition. The amount of obtained CV for this factor is 50% which reveals the disparity among the neighborhoods with respect to the given indicators for this factor.

The last factor is socio-economic factor which is bar-coded by using three indicators such as the average time of residency, the household annual average income and the percent of in-migrated families to the neighborhoods. The results demonstrate that Yourmehaleh has been the most sustained area while

Qaemiyeh, Javaheri and Oloompayeh showed the lowest level of sustainability. By considering the socio-economic factor less than 35% of the Babolsar's neighborhoods are sustainable which reveal the dimension of serious crisis in the level of sustainability of the city. Figure 3 shows the areas of weak and unsustainable in the parts of west and east of the city which are developed in the response to the high residential density of internal sections and also most of the rural migrants found their destination here. The structure of the employment shows that the main job here is dominantly depended to the informal sector and causal works and also some of the households raise animals like poultry and sheep to earn income. The literacy rate is low and they have no professional skills to supply themselves to the formal and relatively high earning sector of the city and therefore threat the sustainability of the city[10]. The obtained CV for socio-economic factor is 52% which indicates the overall weakness of the majority of the city neighborhoods (Table 4 and Fig. 3).

Ranking the neighborhoods by integrated indexes: Since some of the areas have shown a suitable condition with respect to a few of socio-economic factors and other were unsustainable. So to determine the level of sustainability, the integrated indicators were applied to illustrate the level of welfare and living condition (Table 5). The stranded score and Morris methods were used in this research to assign the place of neighborhoods through the different bar-coded indicators. According to the two methods Shahrak daneshgah, Shahrak Qaem and Valiasr had the highest level of sustainability and Shahrak Azadegan, Bibisarroozeh, were the most unsustainable areas of the city (Fig. 4).

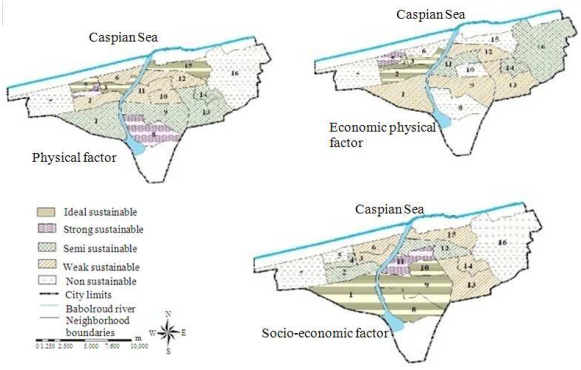

Fig. 3: Spatial distribution of sustainability level (different factors)

The spatial distribution of the sustainability level from integrated indicators indicates that sustained areas are located in the north of the city. The most of the residents belong to the government officials and are high educated. These neighborhoods have good access to the urban facilities and standard housing with a moderated residential density. The price of land is high which lower income group cannot afford it. The unsustainable areas are adjoined to the semi sustainable which housed mainly rural migrants. These areas show the characteristics of shanty town by their low housing quality, high unemployment, poverty, social disorders and alike. The integrated indicators of the semi sustainable areas could be classified in two categories. First the neighborhoods which are located in a close distance to the central part of the city and so have a relative good access to the urban facilities but live in polluted areas with noise and traffic congestion. Second the areas which placed in the periphery of the city and formed during the recent physical expansion of the city.

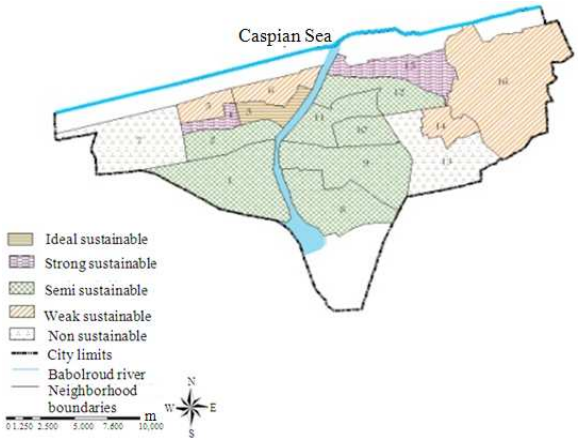

Fig. 4: The level of sustainability of Babolsar (integrated indexes)

Table 5: The level of sustainability by integrated indexes

	HDI			Standard scores		
Neighborhoods	Coficient	Type	Rank	Coeficient	Type	Rank
1	0.524	Semi	6	0.116	Semi	7
2	0.477	Semi	10	0.026	Semi	9
3	0.632	Ideal	1	0.516	Ideal	1
4	0.554	Strong	3	0.287	Strong	3
5	0.412	Weak	13	-0.240	Weak	14
6	0.438	Weak	12	-0.139	Weak	12
7	0.309	Insusatain	16	-0.593	Unsustain	16
8	0.534	Semi	5	0.192	Semi	4
9	0.485	Semi	8	0.020	Semi	10
10	0.489	Semi	7	0.033	Semi	8
11	0/536	Semi	4	0.186	Semi	5
12	0.480	Semi	9	0.127	Semi	6
13	0.359	Unsustain	15	-0.416	Unsustain	15
14	0.410	Weak	14	-0.220	Weak	13
15	0.559	Strong	2	0.290	Strong	2
16	0.450	Weak	11	-0.070	Weak	11

Table 6a: Model summery, variance analysis and prediction coefficient of sustainable development of the neighborhoods variables entered/removed[b]

Model	variables entered	Variables removed	Method
1	VAR00006, VAR00004, VAR00005, VAR00001, VAR00003, VAR00002[a]		Enter

a: All requested variables entered; b: Dependent variable: HDI

Table 6b: Model summary

Model	R	R square	Adjusted R square	Std. error of the estimate
1	0.859[a]	0.737	0.562	0.051909

a: Predictors: (Constant), VAR00006, VAR00004, VAR00005,VAR00001, VAR00003, VAR00002

Table 6c: ANOVA[b]

		Sum of squares	df	Mean square	F	Sig.
1	Regression	0.068	6	0.011	4.214	0.027[a]
	Residual	0.024	9	0.003		
	Total	0.092	15			

a: Predictors: (Constant), VAR00006, VAR00004, VAR00005, VAR00001, VAR00003, VAR00002; b: Dependent Variable: HDI

Table 6d: Coefficients[a]

		Unstandardized coefficients		Standardized coefficients		
Model		B	Std. error	Beta	t	Sig.
1	(Constant)	0.760	0.013		58.524	0.000
	VAR00001	0.003	0.015	0.042	0.212	0.837
	VAR00002	-0.044	0.019	-0.556	-2.360	0.043
	VAR00003	-0.018	0.014	-0.236	-1.282	0.232
	VAR00004	0.054	0.016	0.694	3.303	0.009
	VAR00005	0.039	0.015	0.493	2.646	0.027
	VAR00006	0.042	0.016	0.530	2.707	0.024

A: Dependent variable: HDI

Many of the residents are middle class and have not good access to the medical, health and also pay a higher transport cost, but have a better access to the open spaces and parks.

Predicting the sustainable development priority in the neighborhoods: By using SPSS and the multi-regression model (Enter) the priority of development has been calculated on the base of factor analysis scores. In this research he Human Development Index (HDI) has been considered as depended variable and the scores of the 6 factors as independent variables. R^2 obtained 0.737 which indicates that 73.7% of sustainability level variations could be determined by six factors in the neighborhoods of Babolsar. By decrease of independent indicators the amount of R^2 would be decreased. In fact, such issue indicates that by increasing the number of indicators and also the factors, the percent of sustainability variation of neighborhoods increase. Table 6a-d of ANOVA confirmed the regression significant and the linear relation among the variables with the Sig of 0.027 which is about 99% significant. The main results of regression are depicted in Table 6d of coefficient. Column B is used as coefficient to measure the amount of Y in the regression equation[1]:

$$\dot{Y} = a+b_1x_1+b_2x_2+b_3x_3+\ldots+b_nx_n$$

Where:

Y = The predicted amount of y
a = Width from origin of intersection of regression line or axis of y
b = Regression coefficient of curve gradient
x = Amount of independent variables

According to the column B the regression equation could be as follow:

Y = 0.760+0.003 factor 1+-0.044 factor 2+-0.018 factor 3+0.054 factor 4+0.039 factor 5+0.042 factor 6

In Table 6a-d the amount of t for the each regression coefficient is calculated and the level of significant is illustrated in the last column. As it shows the factors of 4th, 6th, 5th and second are significant, while the first and third one are insignificant and have a weak function to predict the level of sustainability in the neighborhoods.

RESULTS

The importance and role of the factors to predict the sustainability level of 16 neighborhoods would be possible with respect to the amounts of β. It shows that the forth, six and fifth factors have more share compared to others to predict the level of sustainability because one unit of variation in the standard deviation in these factors lead to that the depended standard deviation (HDI) change to 0.694, 0.530 and 0.493. So the predicted factors show the priority of different factors by considering the regression model as follow:

- Physical factors
- Socio-economic factors
- Environmental-economic factors
- Environmental-social factors
- Economic-physical factors
- Infrastructural factors

DISCUSSION

This study attempted to evaluate the level of sustainability and disparities in the neighborhoods of

Babolsar. The research used 30 different socio-economic and physical-environmental indicators by applying descriptive-analytical methods. Also the factor analysis technique was associated with the human development index, standard deviation, coefficient variations and combined multi-regression. In general the research findings from 30 indicators were integrated into six major factors by using factor analysis technique. The results show that despite the all efforts of local and regional development polices the city still suffers from low sustainability as only 20% of the city's neighborhoods could be classified as sustainable areas.

The dispersed coefficient from integrated indexes is 0.93% which indicates the sharp differences among the neighborhoods of the city. These conditions is a reflect of the rapid urban population growth, unbalanced physical expansion of the city, inappropriate use of urban regulation, lack of powers to enact the zoning ordinances and tens of other infrastructural problems.

CONCLUSION

So there is a strong need for implementing long and short term planning strategies. Here with respect to the urban policy challenges and by considering the predictions resulted from multi-regression, there should be taken different action to decrease the social and economic gap among the different neighborhoods of the city. Despite the all efforts of local authorities, action plans such as the master and detail have not the potential to distribute different urban facilities in the whole pars of city. The study revealed using statistical models could show the level and type of sustainability in the urban areas. However, this research came to the conclusion that there is a strong need to do the similar study in the other urban centers of the Mazandaran province to analysis the failure or capacity of the provincial strategies which probably influence the orientation of the local projects and policies.

ACKNOWLEDGEMENT

The researcher would like to appreciate the vice research deputy of the university of Mazandaran for the financial support.

REFERENCES

1. Clark, W.A.V. and P.L. Hosking, 1986. Statistical Methods for Geographers. 1st Edn., John Wily and Sons, ISBN: 10: 0471818070, pp: 528.
2. Cullingworth, B. and V. Nadin, 2006. Town and Country Planning in the UK. 14th Edn., Rutledge. ISBN: 10: 0415358108, pp: 590.
3. Drakakis-Smith, D., 1987. Third World Cities. 2nd Edn., Routledge, ISBN: 0-415-19881-X.
4. Grant, J., 2006. Planning the Good Community; New Urbanism in Theory and Practice. Rutledge, ISBN: 10: 0415700752, pp: 269.
5. Rao Pratap, M., 2001. Urban Planning, theory and PracticeCBS Publishers & Distributers, New Delhi, India, ISBN: 81-239-0757-5.
6. Lotfi, S. and M.J. Koohsari, 2009. Measuring objective accessibility to neighborhood facilities in the city (A case study: Zone 6 in Tehran, Iran). Cities, 26: 133-140. DOI: 10.1016/j.cities.2009.02.006
7. Lotfi, S. and M.J. Koohsari, 2009. Analyzing accessibility dimension of urban quality of life: Where urban designers face duality between subjective and objective reading of place. J. Soc. Indicat. Res. DOI: 10.1007/s11205-009-9438-5
8. Lynch, K., 2004. Managing Urbanization. In: Global Environmental Issues, Harris, F. (Ed.). John Wiley and Sons, Ltd., ISBN: 10: 0-470-84561-9, pp: 195-228.
9. Makhdoum, M., 2001. Fundamental of Land use Planning, Tehran University Publications, ISBN: 964-03-4025-1.
10. Zebardast, E., 2006. Marginalization of the urban poor and the expansion of the spontaneous settlements on the Tehran metropolitan fringe. Cities, 23: 439-454. DOI: 10.1016/j.Cities.2006.07.001
11. Pacione, M., 2001. Urban Geography, a Global Perspective. Routledge, ISBN: 0-415-19195-5, pp: 663.
12. Raven, P.H. and L.R. Berg, 2006. Environment. 5th Edn., John Wiley and Sones, Inc., ISBN: 10 0-471-70438-5.
13. Satterthwaite, D., 1999. The Earthscan Reader in Sustainable Cities, Earthscan, London, ISBN: 9781853836015.