# People and Green Roofs: Expectations and Perceptions of Citizens about Green Roofs Development, an Iranian Case Study

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***Abstract***

*Green roofs, an opportunity to simultaneously mitigate environmental problems and create life-enhancing value, represent a class of technology that can be considered Bioengineering or Biomimicry. The purpose of this study is to explore citizen's expectations and attitudes towards participating in rooftop gardens development related to behavioural, social and demographic variables. To investigate citizen's attitudes towards participation in green roofs development, surveys was conducted in the districts of Zanjan city, Iran. A questionnaire has been designed to solicit opinions from 313 citizens randomly chosen from residents. The statistical analysis of data is performed using the chi-square test and Pearson correlation coefficient. Results show the opinion of citizens about most important benefits and barriers of developing living roofs. While people were interested in installing rooftop gardens, but there were not volunteers. The financial and technical support by municipalities and urban managers is the main expectation of people.*

***Keywords:*** *Participation; Green roof; Urban environment; Sustainable development; Iran*

## 1. Introduction

Rapid development of urbanization, especially in less developed countries has created many negative effects of land use transitions on climate, ecological system and environment. It brings a range of environmental challenges. Many environmental impacts of widespread urbanization have been documented, for example, Owens and Walling (2002), Bay, Jones, and Schiff (2003), Jacobson (2011), Fletcher, Andrieu, and Hamel (2013) identified biochemical and physical changes to hydrological systems. Due to the urbanization process green environments have been deteriorated continuously which led to create an unhealthy urban environment that is an important factor to climate change (Dewalle, Swistock, and Johnson 2000; Huang et al. 2008; Hejazi and Moglen 2008; Hejazi and Markus 2009; Cavan and Kazmierczak 2011; Ismail, Samad, and Rahman 2011; Rouge´ and Cai 2014; Tam, Gough, and Mohsin 2015). Progressive urbanization decreased infiltration of rainfall and increased runoff because of increasing the area of impervious surfaces (Leopold 1994; Gordon et al. 2013). Urbanization affects the operation of local or even the global ecosystems (McDonald 2009).

Urbanization is a multifaceted process, which linked with socioeconomic (demographic, economic, infrastructure) processes as well as land cover and land use changes (Srinivasan, Seto, Emerson, & Gorelick 2013). The urbanization trends in Iran, as other developing countries, differ from historical patterns during the last decades. It had been accelerated by high rates of rural-urban migration along with rapid socioeconomic and political changes that formed unbalanced urban growth in Iran (Asgharpour, Zanjani, & Taleghani 2013). Urbanization changes in Iran have not resulted from the improvement of economic and social functions and the methods of production; rather they have been caused by the high-income gap between economic sectors and the unavailability of work to rural residents (Fanni 2006). Since 1956, the proportion of urban population has increased gradually in Iran. According to Statistical Centre of Iran, the proportion of urban population increased to 71.4 percent in 2011 living in 1331 urban settlements. Urban population in Iran will reach 60% in 2020 according to the United Nations (Zanganeh Shahraki et al. 2011). Population has increased

rapidly and there was an increase in the number of cities (Farhoudi, Zanganeh Shahraki, & Saed Moucheshi 2009). The rapid population increase in this situation is not caused by the urban economic requirements and its necessities, but by the impoverishment and poor economic conditions and also by the high under-development of its surroundings (rural areas) which causes the one side rural-urban migration. The rapid expansion in urban population in Iran in 1980-1990 has occurred without the needed expansion in basic services and productive employment opportunities. Several urban problems have resulted from uncontrolled urban growth in cities. These problems are lack of urban infrastructure, birth of several informal settlements inside and surrounding the cities, inflation, poverty, lack of land and housing, traffic and transportation problems, lack of facilities and infrastructure, equipment shortages, lack of educational, cultural and sports facilities, lack of green spaces and the variety of environmental pollution (water, air, sound). As a developing country, Iran faces challenges of expanding and redeveloping its cities while providing enough urban green spaces and associated ecosystem functions. Some Iranian cities have encountered difficulties in this endeavor. Green spaces have been degraded due to replacement by artificial surfaces, fragmentation and reduction in size.

Evidence of the importance of green space in urban environments is growing. Research is showing a range of benefits such as provide habitats for many species, help control soil erosion by limiting water runoff, reduce the urban heat island effect, and improve air quality by absorbing air pollutants and carbon dioxide (Miller 1997). Urban green spaces are the most significant factors in shaping urban sustainability.

Urbanization processes had led to unequal access to urban green space and associated environmental and social benefits (Kabisch, Qureshi, & Haase 2015). Given the importance of green space in maintaining physical and mental health of citizens, several approaches have been devised to solve the lack of urban green spaces in recent years. One of these solutions that is also taken into consideration in Iran is creating green spaces on the rooftop or developing green roofs.

Nowadays, urban landscapes include roofs that most are abandoned and forgotten. These landscapes are alive at the ground level, but they are lifeless at the roof level (Thompson & Sorvig 2000). Increased urbanization and density in cities, creating more barren, harsh rooftops that seriously affect the people, the economy, and the environment.

In fact, this type of green space in Iran could be a practical and affordable solution to solve many of the environmental problems of cities, but unfortunately, no pattern or design has been scheduled to develop and construct green roofs. In addition, municipalities of cities as the main authorities to maintain and develop green spaces in cities have not taken any impressive step in this case.

The aim of this paper is to study of citizens' perceptions and expectations about the rooftop gardens and their attitude to participate in green roofs development. Earlier studies on people's perceptions of living roofs have shown that in designing and planning of rooftop gardens, people's preferences and expectations are important when urban managers decided to set up obligatory planning approvals or offering subsidies for urban green space development (Fernandez-Cañero, Emilsson, Fernandez-Barba, & Má 2013). In addition, this study examines the relationship between behavioural, social, and demographic characteristics and expectations of people about green roof design. Another aim of this study is to examine perception about the barriers and preconditions of installing living roofs.

## 2. Methodology

This study examined individuals' perceptions about the green roofs and their predisposition to cooperation in green roofs instruction.

### *2.1 Study Area*

The study focused on Zanjan city, the capital of Zanjan province and a middle city located in North West of Iran. The city of Zanjan has a population of 386,851, which is the 20th largest city in Iran. Zanjan is located at 320 km NW of Tehran and 125 km SW of Caspian Sea. It lies in an open valley about halfway along the main road and railway from Tehran to Tabriz and Turkey. The texture and morphology of the city influenced by topographic features, especially the northern mountains and the Zanjanroud River, during its growth. Zanjan has a highland climate characterized by cold, snowy weather in the mountains and moderate climate in the plains in wintertime. In the summers, the weather is warm. The average maximum temperature of Zanjan is around 27 °C, whereas the average minimum temperature stands at -19 °C. Meanwhile, the temperature rises to 32 °C on hot days, whereas it drops to - 27 °C on icy days. The annual rainfall is 300 millimetres.

In the past three decades, this city has faced numerous problems in the process of urbanization and has experienced considerable physical and demographic growth. This growth caused by migration and this massive migration

led to population increase in this city, especially, between 1986-1996, according to the Statistic Centre of Iran. Fast urban expansion has strained the quality of the environment and urban life. Urban greening could be degraded and neglected in the hasty rush towards economic growth (Jim 2012). Nowadays, one of the significant problems in Zanjan city is the lack of urban green spaces. From the total area of this city, about 1495605.16 square meters are allocated to green space, which include 2.26 percent of the total area of the city and 4.99 square meters per capita. While, the Ministry of Roads and Urban Development of Iran proposed 7 to 12 square meters per capita (Bakhshi 2001). Therefore, the amount of green spaces in the city is minimal compared to national standards. Most importantly, due to the lack of available land in the city and the land-use allocation problems, rooftop gardens development is considered as an important and useful approach.

### *2.2 Sampling and questionnaire design*

The population of interest in this research is the citizens of Zanjan city. The stratified random sampling has been used to ensure that estimates has been made with equal accuracy in different districts of the city. According to Municipality of Zanjan city, Zanjan city has 5 urban districts and 25 subdistricts. According to this district division, residents were chosen randomly for interviews in July and August of 2011. Eight postgraduate students served as research assistants conducted the survey together as a group under supervision. The main survey successfully interviewed 313 citizens face-to-face. People completed the questionnaires independently; otherwise, interviewers provided explanations where necessary.

The survey questionnaire included a combination of closed and open-ended questions oriented around our research questions to solicit information. People could also write in additional responses beyond these pre-defined choices. The final survey included 34 questions and took about 30 min.

The questionnaire was intended to be understandable for ordinary people and has been designed in four sections including socio-demographic characteristics, house features, access to green spaces and perception of the living roofs.

The first section looked at citizens' socio-demographic information such as gender, age, education, and income. The second part specifically asked about citizens' place of residence and its situation. The third section explored the people's access and their opinion about the green spaces quality. Then perceptions of people about the benefits or negative effects of green roofs were assessed. Therefore, their tendency to cooperate in rooftop garden instruction was studied using a Likert scale (Alreck & Settle 2004) that is comprised of 5 answer choices of "strongly disagree"(1), "disagree"(2), "neutral" (3), "agree" (4), "strongly agree" (5). Finally, some questions were asked to examine the citizens' perceptions to participate in living roofs instruction.

The potential positive expectations and barriers of green roofs is listed from the most mentioned benefits (Peck et al. 1999; Johnston & Newton 2004; Townshend & Duggie 2007; Dunnett & Kingsbury 2008) and barriers of installation (Scholz-Barth 2001; Sutic 2003; Porsche & Köhler 2003; Ngan 2004; Banting, Li, & Missios 2005; Kaufman, Cox, Muira, & Easterday 2006; Townshend & Duggie 2007; Andros & Maclin 2007; McRae 2013) in the bibliography. A literature review provided an overview of rooftop gardens benefits in general. The value of these benefits is then examined in the context of the Zanjan city by identifying existing problems that living roofs may be able to address. To complete the list of potential positive expectations and barriers, some other native negative effects related to the characteristics of Iranian community were added to the list (Ansari and Keshtkar Ghalati, 2006; Nehreli, Abdollahi, and Valibeigi 2011).

### *2.3 Method of the data analysis*

A quantitative approach was used to analyse the data collected from the 313 questionnaires applying SPSS v.22. The standard deviation and mean is estimated for variables. Statistical analysis is performed using the chi-square test. Correlation (Pearson correlation coefficient) were performed to examine the correlation between the personal and social characteristics and perceptions of citizens about the green roofs and their readiness to participate in rooftop gardens instruction.

## 3. Results and Discussion

### *3.1 Socio-demographic characteristics*

The most important socio-demographic features of the 313 survey respondents have been shown in Table 1. The questionnaire involved some questions to obtain data about socio-demographic characteristics of citizens. These characteristics include gender, age, marital status, occupation, education, home ownership, and living place.

Considering demographic features of the people shows 53.7% were male and 46.3% were female. The average age of citizens who involved in the survey was 32 years (range: 14-80). Only 35.1% of the citizens have a bachelor's degree and higher. The majority of surveyed citizens (64.2%) were married and only 35.8% were single. Most of them said that they were self-employed (49.2%). More than 75% were the owner of the house, and the houses of 23.3% were renting. The majority of surveyed people (80.2%) lived in a house and only 19.2% currently lived in an apartment.

**Table 1.** Characteristics of the samples (Sample size, N=313)

| Gender | (%) | Age | (%) | Marital Status | (%) |
|---|---|---|---|---|---|
| Male | 53.7 | Less than 20 | 10.12 | Single | 35.8 |
| Female | 46.3 | 20-29 | 35.69 | Married | 64.2 |
| | | 30-39 | 28.1 | | |
| | | 40-49 | 14.04 | | |
| | | 50-59 | 6.54 | | |
| | | More than 60 | 5.51 | | |
| Degree of education | (%) | Occupation | (%) | Home ownership | (%) |
| High school or less | 33.23 | Student | 13.12 | Freehold | 75.71 |
| Diploma | 31.63 | Employed | 20.18 | Rental | 24.28 |
| 2-year degree or bachelor's degree | 30.67 | Self-employed | 49.2 | | |
| Higher than a bachelor's degree | 4.47 | Military and protective service | 0.33 | | |
| | | Retired | 5.29 | | |
| | | Out of work | 2.33 | | |
| | | Homemaker | 9.55 | | |
| Living place | (%) | Distance between home to nearest green space | (%) | Spend some time in public green spaces | (%) |
| House | 80.2 | Less than 2 km | 72.5 | Yes | 40.32 |
| Apartment | 19.2 | 2-5 | 22.7 | No | 59.68 |
| | | 6-10 | 3.5 | | |
| | | 11-20 | 0.6 | | |

### *3.2 Study of the public perception*

In the second section of the questionnaire, citizens were asked how far their home is away from the nearest green space. As shown in table 1, 72.5% determined the distance between their home to nearest green space less than 2 km, 22.7% 2 to 5 km, 3.5% between 6 and 10 km and 0.6% between 11 to 20 kilometers.

In addition, people answered some questions to discover their assessments about the quality of green spaces in their neighborhoods. Of the people surveyed, only 40.32% spend at least some time in public green settings. While access to open spaces and leisure facilities has direct and indirect impacts on physical and mental health of people (Chen 2006; Maas Verheij, Groenewegen, de Vries, & Spreeuwenberg 2006; Liu, Wilson, Qi, & Ying 2007; Coombes, Jones, & Hillsdon 2010; Lee & Maheswaran 2010; Barton & Pretty 2010; ). Urban green spaces generate many tangible and less tangible ecosystem services, including outdoor recreational opportunities, amenities, air pollutant removal, rainwater retention, soil moisture and groundwater recharge, flood control, cleansing of return water flow, wildlife habitat, and health promotion (Chen 2006).

Unfavorable atmosphere because of the wrong people, lack of green space and long distance to green space from home, lack of time, and low quality of green spaces (no scenery and beautiful landscape and citizen-friendly setting, no adequate facilities and play equipment) are the main reasons behind the widespread dissatisfaction of citizens with the existing green spaces in the city (Table 2).

**Table 2.** Reasons for not spending time in public green spaces (N=127)

| The main reason for not spending time in public green spaces | N | (%) |
|---|---|---|
| Unfavorable atmosphere because of wrong people | 63 | 49.6 |
| Lack green space access in neighborhood | 45 | 35.43 |
| Lack of time | 15 | 11.81 |
| Low quality of green spaces | 4 | 3.14 |

To discover citizens' perceptions about the benefits of installing living roofs, several questions were asked. As shown in Table 3, offering an attractive view and increase visual aesthetic value, providing a new space for entertaining, and reducing air pollution were the benefits obtained the highest average score. A noticeable benefit of rooftop gardens is the eye-catching view offered to overlooking buildings, which is imperative in a dense urban environment with grey concrete slabs and the various paraphernalia of pipelines, electrical and mechanical equipment. These roof gardens also offer opportunities for social interaction between neighbours in both commercial and residential spaces. In an urban environment with limited open space, these roof gardens provide recreational space and amenity that is essential for healthy life of urban dwellers.

Green roofs can also reduce pollution by filtering out dust particulates and other pollutants as the air passes over the plants (Bass and Baskaran 2003; Currie & Bass 2008). Previous researches have demonstrated that green roofs can trap up to 95% of cadmium, copper, lead, and 16% of zinc (Dunnett & Kingsbury 2008). Other researches have represented that 1 square meter of grass can remove 0.2 kg of airborne particles per year (Green roofs for healthy cities 2005).

That is worth noting that the possible benefits of rooftop gardens with the lowest average score were (sorted from lowest to highest) that they increase the longevity of the roof membrane, conserve energy and reduce sound reflection and transmission and help to manage the storm water runoff. Considering that, Zanjan has a cold climate with cool and moist winters; it is unusual that citizens do not recognize the energy conservation as a possible advantage of living roofs. It indicates that the citizens had difficulty believing that green roofs could be profitable due to achieving greater energy efficiency in the buildings. In the city of Zanjan specifically, where cold weather is somewhat of an imperative issue, rooftop gardens could insulate houses in the cold conditions and lower the energy demands of the building's heating system. Because the buildings spend a considerable amount of money annually on energy costs, expenditures such as the heating systems that could be reduced extensively by building green roofs. Moreover, the weather of Zanjan city is warm in the summers. Although initially designed to insulate houses in the cold conditions of Iceland and Scandinavia, green roofs offer similar benefits in warm climates. During warm weather, these roofs reduce the amount of heat transferred through the roof, thereby lowering the energy demands of the building's cooling system (Del Barrio 1998; Onmura, Matsumoto, & Hokoi 2001; Theodosiou 2003; Liu 2003; Saiz, Kennedy, Bass, & Pressnail 2006). Furthermore, the proportion of positive answers to the question that if they might be interested in building rooftop gardens on their house were 80%.

**Table 3.** Assessment of the benefits of installing green roofs (N=311)

| Reasons to install green roofs | Mean | SE of Mean | Median | Mode |
|---|---|---|---|---|
| Offer attractive view and increase visual aesthetic value | 3.85 | 0.05 | 4 | 4 |
| Provide a new space for entertainment | 3.71 | 0.05 | 4 | 4 |
| Reduce air pollution | 3.58 | 0.06 | 4 | 4 |
| Help promote health | 3.35 | 0.05 | 3 | 3 |
| Make it possible to cultivate vegetables, fruits and herbs | 3.28 | 0.06 | 3 | 4 |
| Increase property values | 2.88 | 0.05 | 3 | 2 |
| Help to manage the storm water runoff | 2.79 | 0.05 | 3 | 3 |
| Energy conservation and reducing sound reflection and transmission | 2.72 | 0.05 | 3 | 2 |
| Increase longevity of the roof membrane | 2.71 | 0.05 | 3 | 2 |

Considering the disadvantages (Table 4), the main barriers of installing living roofs with the highest average score were lack of knowledge and awareness, lack of standard construction equipment on these roofs and lack of architectural considerations in the current buildings of the city. The extent to which respondents mentioned lack of knowledge about the possible advantages of installing green roofs is outstanding. There is very little awareness of rooftop gardens in Iran. The lack of green roof pilot projects; the uncertainty within the market over costs and benefits; the lack of local research on green roof advantages and disadvantages; and the unfamiliarity among users and clients, all act together as a barrier against the development of living roofs in this city. It is also remarkable to note that the disadvantage with the lowest average score is the high consumption of water in the green roof irrigation. Regarding that Zanjan has a cold semi-arid climate with hot, dry summers and cool, moist winters and very low precipitation it is surprising that people do not recognize water consuming as a possible disadvantage. Dunnett & Nolan, (2004) argued that providing an irrigation system in green roofs is necessary in areas with hot and dry summers.

**Table 4.** Barriers of installing green roofs (N=312)

| The main barriers of installing green roofs. | Mean | SE of Mean | Median | Mode |
|---|---|---|---|---|
| Lack of knowledge and awareness | 4.23 | 0.05 | 4 | 5 |
| Lack of standard construction equipment on green roofs | 3.96 | 0.05 | 4 | 4 |
| Lack of architectural considerations in the current building of the city | 3.94 | 0.05 | 4 | 4 |
| High up-front costs related to the implementation of green roofs | 3.90 | 0.05 | 4 | 4 |
| Concerns about the negative consequences of the green roof construction (Waterproofing, strength of the buildings…) | 3.83 | 0.05 | 4 | 4 |
| Unfamiliarity among citizens about benefits of green roofs | 3.55 | 0.06 | 4 | 4 |
| No patterns of green roofs in the city | 3.55 | 0.06 | 4 | 4 |
| Lack of incentive / statutory mandate | 3.45 | 0.06 | 4 | 4 |
| Concerns about building strength and bearing an additional burden on the roof | 3.38 | 0.06 | 3 | 4 |
| Lack of expertise in the design and implementation of green roofs | 3.37 | 0.06 | 3 | 4 |
| Lack of public or private institutions to provide specialized consulting services | 3.25 | 0.06 | 3 | 2 |
| Cultural challenges of using common green spaces on the top roof, according to religious and cultural features of citizens | 3.24 | 0.06 | 3 | 4 |
| Not enough interaction between citizens and authorities | 3.24 | 0.06 | 3 | 3 |
| Have an expensive maintenance | 3.11 | 0.05 | 3 | 2 |
| Legal problems of common areas in the apartment | 3.08 | 0.06 | 3 | 2 |
| Lack of specialized centers to provide construction equipment of green roofs | 3.07 | 0.06 | 3 | 2 |
| Uncertainty on the correct plant species for use on green roofs | 3.00 | 0.06 | 3 | 2 |
| Have a high consumption of water for irrigation | 2.79 | 0.06 | 3 | 2 |

Additionally, citizens answered several questions to find out their perceptions about their willingness and readiness to participate in installing rooftop gardens. As noted in Table 5, the potential readiness of neighbours to participate in installing rooftop gardens is less valued by the respondents comprised their willingness to cooperate with neighbours in building living roofs. It is interesting that people have shown themselves prepared to cooperate while they have not sure about the participation of their neighbours in the green roofs construction. Most respondents (30.4%) might be attracted to participate in the planting stage, 24% prefer to be involved in the care and maintenance of plants and 16.6% were willing to cooperate in the design of these roofs. It is interesting to note that the willingness of citizens to invest in the green roof construction is low, 4.2%. Meanwhile, 6.1% preferred to participate in the stage of construction (technical) and 4.8% have expressed their interest to collaborate in all steps. Taking into account that participating in investing in the green roof construction is an important issue in installing green roofs, low willingness of citizens could be an important barrier to developing these roofs in the city.

**Table 5.** Participation of citizens in the green roof construction (N=311)

| Participation of citizens in green roofs construction. | Mean | SE of Mean | Median | Mode |
|---|---|---|---|---|
| Willingness to cooperate with neighbors in building green roofs | 3.53 | 0.06 | 4 | 4 |
| Readiness of neighbors to participate in building green roofs | 2.59 | 0.05 | 2 | 2 |

In the other section of the questionnaire, citizens were asked which incentives might be essential to encourage people to participate in the green roofs construction. As shown in Table 6, the three potential incentives with the highest average score were (in order from highest to lowest) the technical support and loan offered by municipal and authorities of urban green spaces and holding training courses for citizens. It makes sense that financial and technical support by municipalities and urban green space management could play an important role in green roofs development strategies. It should be noted that the incentives that were less valued by citizens were (in order from lowest to highest) solving legal problems of common buildings and providing specialized consulting services.

**Table 6.** Incentives to participate citizens in the green roof construction (N=311)

| Main incentives to participate citizens in green roofs construction. | Mean | SE of Mean | Median | Mode |
|---|---|---|---|---|
| Offering technical support by municipalities and authorities of urban green spaces | 3.70 | 0.05 | 4 | 4 |
| Offering loan by government and municipal | 3.58 | 0.06 | 4 | 4 |

| | | | | |
|---|---|---|---|---|
| Holding training courses | 3.55 | 0.06 | 4 | 4 |
| Participation of neighbors | 3.54 | 0.06 | 4 | 4 |
| Providing specialized consulting services | 3.26 | 0.06 | 3 | 3 |
| Solving legal problems of common buildings | 3.12 | 0.06 | 3 | 3 |

Investigating the relationship between some behavioural and social characteristics of the citizens and their interest in installing living roofs shows that the interest of individuals in installing green roofs seems to be significantly related to their age (p=0.015). Younger citizens had more interest to the green roof construction than older ones (Table 6). However, as presented in Table 6, there is no significant relationship between the level of interest and other characteristics, such as gender, degree of education, type of housing, having a yard at home, distance between home to nearest green space, spending some time in public green settings or feeling lack of green spaces.

**Table 7.** Relationship of several sociological parameters of citizens with the interest of installing green roofs (N=307)

| | Pearson chi-squared test[b] | | |
|---|---|---|---|
| | $x^2$ | *df* | *p* |
| Gender | 2.305 | 2 | 0.316 |
| Age range | 14.078 | 5 | 0.015 |
| Degree of education | 7.386 | 3 | 0.061 |
| Type of living house | 1.744 | 2 | 0.418 |
| Have a yard at home | 1.744 | 2 | 0.418 |
| Distance between home to nearest green space | 1.474 | 4 | 0.831 |
| Spend at least some time in public green settings | 3.266 | 3 | 0.352 |
| Feeling lack of green spaces in their living environment | 2.54 | 4 | 0.638[a] |

[a] It is calculated using SPSS Exact Tests v.22

[b] Chi-squared test based on responses to several questions and some demographic features: Gender (1=male; 2=female); Age range (1=Under 20 years; 2=between 20 and 29 years; 3=between 30 and 39; 4=between 40 and 49; 5=between 50 and 59; 6=over 60 years old); Degree of education (1=High school or less; 2= Diploma; 3=2-year degree or bachelor's degree; 4= higher than bachelor's degree); type of living house (1= apartment; 2=house); having a yard at home (1=Yes, 2=No); Distance between home to nearest green space (1=less than 2 km; 2=2-5 km; 3=6-10; 5=11-20 km); Spending at least some time in public green settings (measured on a scale from 1= strongly disagree to 5=strongly agree); Feeling lack of green spaces in their living environment (measured on a scale from 1= strongly disagree to 5=strongly agree).

### *3.3 Effect of socio-demographic characteristics on the public perception of green roofs*

Several demographic variables, including gender, age, degree of education, and current housing for interesting in participating in installing rooftop gardens were analysed separately using Pearson Chi-Squared test. A value of $p<0.05$ (2-sided) is considered to be statistically significant. Willing of individuals to participate in installing green roofs (Table 8) appears to be meaningfully connected to their interest in installing a green roof (p=0). Also, Participating of neighbours in installing a green roof seems to affect (p=0) willing of individuals to participate in building a green roof on their homes. However, as presented in Table 8, there is no significant relationship between the level of interest in installing a green roof and other characteristics.

**Table 8.** Relationship of several sociological parameters of citizens with the interest of participating in installing green roofs (N=313)

| | Pearson chi-squared test | | |
|---|---|---|---|
| | $x^2$ | *df* | *p* |
| Gender | 6.361 | 8 | 0.607 |
| Age range | 31.135 | 20 | 0.053 |
| Degree of education | 12.034 | 12 | 0.443 |
| Current housing | 10.258 | 8 | 0.247 |
| Have a yard at home | 10.258 | 8 | 0.247 |
| Distance between home to nearest green space | 15.924 | 16 | 0.458 |
| Spend at least some time in public green settings | 12.175 | 12 | 0.432 |
| Feel lack of green spaces in their living environment | 20.581 | 16 | 0.195 |

| | | | |
|---|---|---|---|
| Knowing about green roof | 11.684 | 8 | 0.166 |
| Interested in building a green roof on their house | 64.717 | 4 | 0 |
| Participate of neighbors in building a green roof | 89.299 | 16 | 0 |

## 4. Conclusion

Considering the historical background of using mud and brick in architecture in Iran, mosses, lichens and a variety of herbaceous plants have been used on the roof of buildings across the country especially in Azerbaijan, Gilan and Mazandaran in mountainous and rural houses. The village houses in Masuleh where the roof of the lower houses works as the yard of the upper houses is an example of plants growing on rooftops. Although living roofs become the typical and partly essential element of buildings in European countries and emerging and growing elements in North America and East Asia, but in many countries, as Iran, it remains unknown. Although some projects has been done in Iran in the past, but they have not developed continuously. On the other hand, due to the high value of land in cities, and consequently the vertical growth of the city, the low area of green space and inappropriate distribution in the neighbourhood, according to international standards, rooftop gardens seems to be a good choice.

This study investigated the public perception for green roof design in the city of Zanjan, Iran. Results have shown that offering an attractive view and increase visual aesthetic value is the most important benefits of installing rooftop gardens according to citizen's attitude. In the examples of these roofs through the country, the main purpose of designing rooftop gardens is creating decorative landscapes not developing sustainable green spaces at the neighbourhood level. While the long-term objective of green roofs is to achieve collective environmental benefits through citywide application. On the other hand, lack of knowledge and awareness about features, benefits, design and install the living roofs are the main barrier of installing rooftop gardens in this city. So increasing public awareness about the importance of urban environmental quality issues and the need for participation of all people in it is an essential step to develop green roof projects. It is important to encourage policy makers, professionals, the mass media, building contractors and owners, landscape architects and the public learn about the advantages and benefits of green roofs.

This study showed that although people were strongly interested in installing rooftop gardens on their house, but there were not volunteers to invest in the green roofs construction. Because participating of neighbours seems to influence willingness of individuals to participate in installing a green roof on their homes. In addition, they accentuated the financial and technical support by municipalities and urban managers to participate in green roof installing. We believe that government has a key role in developing rooftop gardens in Iranian cities. So increasing collaboration between authorities and specialized agencies, NGOs and private developers could meet the needs and problems of developing living roofs. Although it is essential to reduce technical issues and uncertainty by providing financial support for increased research and creating high standards for both retrofitted and new installations. All levels of government should actively support rooftop gardens, by introducing relevant procurement policies, implementing aggressive plans for installations and making it mandatory to include these technologies in new buildings. Introducing grants or indirect subsidies to reduce payback periods and associated economic uncertainties might encourage private owner installations. Authors believe that further city-specific studies with a larger and diverse sample need to be taken up.

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