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An investigation of urban green roof development in developing countries (A case study of Iran)

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ABSTRACT

The high added value of urban land and the low coverage of green space with the inappropriate distribution made the application of green roof technology an appropriate option for sustaining urban environment of the Iranian cities. Despite the potential of this technology such idea did not materialize in urban planning in the last decades. This paper tries to investigate the main obstacles of green roof development in the urban areas. The methodology of the research is based on descriptive-analytical which a field survey was conducted to obtain the required data and information. Analytical Hierarchical Process (AHP) model was applied to identify the real reasons behind the zero use and development green roof in Iran on the base of local necessities. So by studying different experiences and resources about the development of green roofs and using the comments of relevant professionals, the main aspects of the lack of green roof development were examined which the result was specified into six main viewpoints. Experts' opinions were evaluated according to priority of criteria and strategies. Then the final priority of strategies was acquired through the results. This model was used to evaluate the efficiency in providing the optimal strategies of green roofs. In this field, obstacles are as follows: lack of vision as environmental guideline, low cost of energy carriers, as well as the lack of codified standards, lack of local green roof industry, and finally limitation of applied researches The proposed strategy is to apply successful experiences in using green roofs in the leading countries to promote quality of urban environment along with other advantages of this technology through state initiative for involving the private sector.

Keywords: Urban green roof, urban ecosystems, environmental quality, Iran

1. INTRODUCTION

One of the main challenges of urban areas is development of urban green space and its appropriate distribution in different neighborhoods in countries with rapid urbanization growth like Iran. Since open space seems have no direct economic value are in the exposure of short term land use change on the base of market forces. Now such

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problems are wide spread in both developed and developing countries but the extend of green space changes are less evident in advanced countries due to the presence of green activists who usually give public awareness also the enactment of firm environmental laws to protect these land uses (PGSTM 2010). The private developers allocate a small area of land for green space to reduce the costs and gain more profits; which prevailed in higher dense areas. So it is almost impossible to develop green space in appropriate scale in the congested areas which the only way seems to be the application of green roof to create visual aesthetic and restore climate conditions (Kralli *et al.* 1996). Green roofs play an influential role in the energy flow of buildings by reducing negative impacts heat islands. Green roof can act as noise preventer (Dunnett and Kingsbury 2004) and increase the resistance of building against fire (Porsche and Köhler 2003); they provide many socio-environmental advantages in different scales (Hui 2006).

2. PROBLEM STATEMENT

Green roof is one of the new approaches in architecture and urbanism which derived from concept of sustainable development and used for increasing the green per capita to promote environment quality in cities. Application of green roof could be as optimized use of urban lands (PGSTM 2010). Green roofs are known as gardening in roofs or a technology for cultivating plants in roof of buildings; so that they are alive organs and ecosystem (Roseen et al 2007) which provide an optimal habitat for urban environs (Ansari and Keshtkar 2006). In other words, urban green roofs play multi-functional roles such as improving the quality of air, reducing the volume of surface runoff, mitigating the impact of heat islands (Table 1). There are vast lands in urban areas which covered by asphalt and hard materials which absorb solar radiation and reflect it in night. This leads to environmental problems in urban ecosystem. However such problem could be removed by alteration of building characteristics as in average roof cover 32 percent of urban built environment of cities (Frazer 2005).

Table 1 Advantages of urban green roof

Aspects	Avantages
Ecology	Preserving biodiversity and creating new habitat
	Improving the ecological and environmental quality of cities
Climate	Mitigating the impact of heat islands
	Cooling effect
	Reducing the effect of cold wind and termal insulator
Quality of urban environment	Improving air quality
	Oxygen and Carbon dioxide exchange
	Reducing noise
	Reducing runoff
	Increasing water quality and preventing pollusion
	Reducing electomagnatic radionts (up tp 99%)
	Reducing the cooling cost in warm seasons

Economic and cultural	Increasing the sense of place
	Recreation and health
	Economising energy (insulator coverage in winter)
	Creating multiplier green space
	Increasing the age of roof insulator

(Peck et al 1999)

Despite the luxurious nature of ancient garden as assets of rich people like Babel suspension gardens in 600 BC; Green roofs are heritage of indigenous architecture of different countries (Werthmann and Valkenburgh 2007). The history of green roof and vertical garden date back to suspension garden of Babel and Roman Empire in response to population pressure in urban areas (Farrar 1996). Romans planted trees above the governmental buildings and toms of the rulers (Pieper 1987). Wickings covered the walls with lawn to prevent against wind and rain and in some cars used alga for roof insulator (Donnelly 1992). Many of design thinking are owed to Le Corbusier and Frank Liod Wright who have been the first modern advocators of using green roof as green space for cities. Le Corbusier introduced five principles for designing modern buildings which one of them has been green roof or roof garden (Werthmann and Valkenburgh 2007). Green roofs are obviously the natural result of philosophical school of American Prairie which emphasized on the growth of cities in an organic landscape. From early 60s the concerns about environment quality in urban areas particularly the central parts with heat island and energy crises highlighted the approach of green roof (PGSTM 2010). Today technology of green roof is growing in Europe and America (Peck et al 1999; Beattie 2004). In highly urbanized countries like Jupon, Singapore, Germany and Belgium, the results and advantages of green roof became an incentive for urban government to develop widely this technology (Osmundson 1999; Wertmann and Valkenburgh 2007). The large share of this growth is owed to approval of laws and the allocation of municipality subsides for establishing green roof structures; zoning ordinances in Germany has supported the technology (Dawson 2002). Statistics show that in 2006 more than 75 European municipalities provided scheduled plans for development of green roof on the base of executive guidelines (PGSTM 2010). In Linz, Atrish developing green roof became compulsory residential and commercial buildings with more than 100m^2. In Asia, Jupon accepted a regulation for Tokyo; buildings with more than 1000m^2 should plant 20 percent of their roof with green coverage (Cutlip 2006).

Iran's history of architecture shows that the country has a rich experience of using green space in areas of Azerbaijan, Mazandaran and Guilan. The country as an arid and semi-arid region always had a great attachment to green space. The most thriving example of such affection is visible in Masooleh a beautiful small town in the north of Iran where buildings are arranged in a trace slope which the lower roof used for cultivation of flowers and vegetables. Despite the history of such technique in Iran, the unprecedented growth of urbanization made the architectural tradition unimportant by replication of modernism in urbanism. There are a few efforts in some parts of capital Tehran to develop green roof but the technology still is in its initial stage and in fact it seems multiple problems confined the application of such technology. Tehran as mega-police with 14 million populations now suffer from intensive air pollution particularly

during the recent years, huge pollutant particles invade from south west part of the country from Iraq and deserts of Saudi Arabia. This paper attempted to study the main obstacles and constrains of green roof development in the country by surveying the related documents.

3. RESEARCH METHODS

Diverse aspect s interact each others in the field of Green roof planning, which using multi-purposes model could be appropriate as this technique provides a hierarchical framework for the modeling process of an issue with different aims and sometimes even contradict. Also it make possible to consider quantitative and qualitative criteria. This analytical process regards different alternatives in decision making and provides the prospect of sensitivity analysis of criteria and sub-criteria. This process is a set of judgments and decision making in a logical way (Rasafi and Zarabadi 2009). The main goals (the obstacles of green roof development) are in the upper level of hierarchical structures and the selective alternatives investigate in the lower level. The criteria and sub-criteria could be found by moving between the lower and upper levels In this general structure the obstacles of green roof development are as goals in the above of the figure and the relevant aspects are organized in next level; then the related strategies are emphasized and finally the effective options for developing green roof are revised and corrected. Six main components were recognized based on the investigation of all documents and experiences in the field of green roof development and its connection with urban quality of life with the help of municipality experts. The existing problems of green roof development were analyzed by prioritizing the main components. At first separate matrixes prepared for each component and then a pair wise comparison was done by experts for each sub –group. Expert Choice was applied to prioritize each factor with the help of AHP. The strategies were determined with respect to priorities and then the diagram of efficiency sensitivity analysis was designed for all criteria. To recognize the main components of green roof development, the opinions of 15 experts from university professor to executive manger of urban parks were interviewed. Also for prioritization of main components, a questionnaire was designed and distributed among the 100 environmental experts. The main measures were defined on the base of expert ranking.

4. FINDINGS

By application of the different models six sets of factors are rendering urban green roof development in Iran. As Figure 1 and table 2 show limitaion in investment and managerial with uncertainity in legal ramwork of the urban develoment palns are three main obstacles which made the projcet unimportant in excutive policies.

F3 (Financial)
F2 (Managerial)
F6 (Legal)
F4 (Infrastructural)
F1 (cultural)
F5 (Geographical)
I inconsistency
with 0 missing judgments

Fig. 1 Priority and importance of criteria and main factors of green roof undevelopment

Table 2 Priority and importance of each criterion and main factors of green roof un-development

Row	Factors	Weight	Importance
F1	Cultural aspects	0.066	5
F2	Managerial and policy	0.283	2
F3	Financial	0.314	1
F4	Technical and scientific aspects	0.084	4
F5	Geographical aspects	0.039	6
F6	Legal aspects	0.213	3

Also the results regarding to the each main component illustrated more details from application of AHP model (Table 3). The final synthese revealed different aspects of prevaling problems in implementing green roof project in the country. Fig. 3 shows the integrated factors and components of green roof development.

Table 3 The integrated results from all obstacles of green roof development in Iran

Row	Rank	Factors
A		**1.Investment**
A1	1	Different costs of estabilishing green roof with respect to materials
A3	2	low-priced energy and unwillingness of consumers to decrease energy per capita
A7	3	Lack of financial funds from state or none-state sources
A6	4	Different costs of maintaining green roof for developers
A2	5	Lack of financial helps to private and public developers
A4	6	Lack of plans with economic validation
A8	7	Extra costs for preserving the plants
A5	8	Lack of information for private sector about the turnover of investment
B		**2.Manergement and policy**
B5	1	Lack of attention to green roof as part of green space in the city
B1	2	Low knowledge of middle urban managers about the benefits of green roof
B4	3	Weak development of information about experiences of world
B2	4	Lack of a symbol project in the country
B7	5	Weak tendancy toward using other experiences
B6	6	Lack if incentive for private contractors

B3	7	Lack of native standards to emphasize the necessity of estabilishing green roof
C		**3.Legal aspects**
C1	1	Lack of proper legal motivation for private speculation
C2	2	Lack of approved laws for creating green roof in urban buildings
D		**4.Infrastructure, technical and scientific aspect**
D2	1	Easyness in building of normal roof and access to its materials
D8	2	Lack of experience and knowledge of green roof industry
D4	3	Lack of native industry of green roof
D1	4	High cost of estabilishing green roof for apartments and commertial buildings
D5	5	Lack of soft and hardware systems for consultation
D9	6	High potential of normal roof with any kind of simple architecture
D6	7	Lack of appiled reserch in this field
D3	8	Low quality of the existing knowledge of green roof
D7	9	Unability of using irrigation potential in the country
E		**5. Cultural aspect**
E4	1	Close combatibilty with common roof
E2	2	Lack of general participation of people to keep green roof
E5	3	Lack of public traning to public and oveall management
E1	4	Lak of NGOs to protect and encourage green roof development
E3	5	Lack of public education about the importance of environmental impact of green roof
E6	6	Lack of pblic awarness about the advantages of green roof in physical quality of cities
G		**6. Geographical aspect**
G2	1	Lack of suitable condition from geographical aspect
G1	2	Harshness of climate in some cities

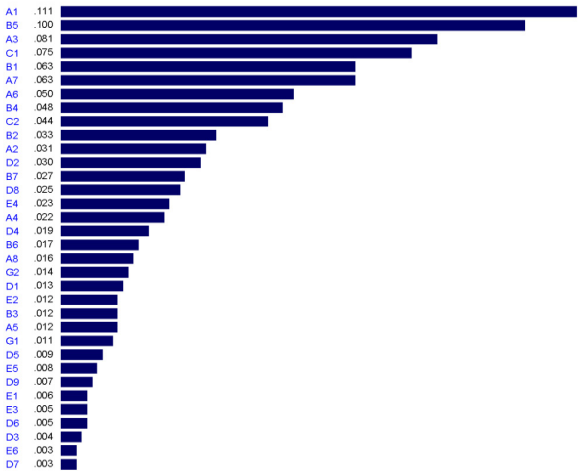

Fig. 2 Integrated factors and components of green roof development

5. DISCUSSION AND CONCLUSIONS

Regarding to the final diagram the most important obstacle of green roof development in Iran is the high cost of estabilishing green roof compared to common roof. The price of giir is very cheap in the oil reach country of Iran which make people to choose none green roofs. Such situation makes the long-term and mid-term benefits of green roof difficult since it is a cost-consuming technique in the first step. The second obstacle relates to the manegerial and policy aspects which have not been able to justify green roof as important part of sustainable devlopment of cities in the country; where air pollusion is a seroiuos problem. It seems that urban master palns do not pay much heed to activate construction codes about development of green roof with firm regulations. Also there is no applied researches and projects to encourage the application of this technique in country. Lack of proper information about the real advantages of green roof among the people, even managers and investors; discouraged them to pursue this project in Iran. The findings of this research showed similarities with many different experiences in Europ and America as the main problem was resulted from economic issues. This study indicated that urban planners need to believe the benefits and then try to apply the technology by learning professional skills from pioneer countries. With respect to the existing complications and the world experiences of green roof development the following proposals are made by this research:

-Development of local based technology for green roof accord with local climate
-Introducing plants compatiable with different climatic conditions of the country
-Encouraging private sector to participate in development of the project
- Intervension of government by founding the project via subsid tool
-Conducting applied research in this field to provid a good background for green roof development
-Legislating building codes for the new development of urban structure to be complusary for developers
-Increasing the awareness of public to apply in their buildings
-Cooperation of municipalities with environmental NGOs to introduce the project
-Using other countries experiences to estabilish an efficient technology

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