UNIVERSITI TEKNOLOGI MARA

CONFERENCE PROCEEDING

ICITSBE 2012

1ST INTERNATIONAL CONFERENCE ON INNOVATION AND TECHNOLOGY FOR SUSTAINABLE BUILT ENVIRONMENT

16 -17 April 2012

Organized by:
Office of Research and Industrial Community And Alumni Networking
Universiti Teknologi MARA (Perak) Malaysia
www.perak.uitm.edu.my

PAPER CODE: GT 19

THE INVESTIGATION OF ESTABLISHING GREEN ROOF INFRASTRUCTURE IN IRAN'S METROPOLITANS

Mojtaba Valibeigiand Mehdi Abdullahi
Faculty of Social and Human Sciences, Department of Geography and Urban Planning, Tabriz, Iran,
valibeigi@tabrizu.ac.ir

Abstract
This article studies the effective factors in the development of green roofs in Iran based on Hierarchical Analysis. Due to the high value of land in the main cities of Iran especially Tehran and the low capitations of green spaces;the use of green roof and its dependent technology can be a good selection to arrive at green government goals. Hierarchical Analysis was used in this study to show the 6 main axes in the development of green roofs that the fund sources. Economic issues, policies and organizational management were the most important factors followed by legal aspects, technical and scientific infrastructure, cultural environment and geographical environment. The subsequent processes were the determination of effective factors in subgroups and the formulation of a final synthesis of administrative actions and a performance sensitivity analysis diagram. Based on these, most problems in development green roofs in Iran were identified as higher costs to conventional roofs, lack of legal frameworks, low energy costs in Iran and other factors which were described in details. Finally according to available issues, the green roof development needs to determine the policies and strategies and hence provide the necessary infrastructures, incentives and legal administrative actions coupled with public participation and skilled manpower to maximize the use of sector capacities in this field.

Keywords: Green roof, Green spaces, Hierarchical Analysis, Energy Efficiency.

1. Introduction

Green roofs are an important technology and planning tool that can be used to help urban centers respond to climate change and improve urban environmental quality(Williams and others, 2010: 245). Despite the nascent nature of the industry, there has recently been a surge of interest in green roofs in cities and the industry may experience rapid growth if the barriers to their implementation can be overcome(Williams and others, 2010, Skinner, 2006). Architects are now regularly including green roofs and walls in proposals and designs, sometimes with little understanding of the technical challenges involved. Planners and policy makers are also becoming increasingly aware of green roofs as a tool for improving the quality of the urban environment (Williams and others, 2010: 246). Also green roof referred to as living roofs or roof gardens, green roofs are roofs and podiums with vegetation growing in a specifically designed substrate. They have multiple demonstrated environmental benefits at a variety of scales. Benefits for individual buildings include increased roof life, insulating properties that lead to greater energy efficiency through reduced summer cooling and winter heating costs and attenuation of inside and outside noise levels (Williams and others, 2010: 245 see also Kosareo and Ries, 2007 .Sailor, 2008. Van Renterghem and Botteldooren, 2009).

Green roofs can help reverse the negative effects of urban sprawl by reintroducing green space into the concrete expanse. By absorbing and detaining water during rain storms, green roofs reduce the flow of stormwater into sewer systems. With less sewer overflows, the water ways are less polluted. Additionally, green roofs can filter various pollutants out of the runoff before it enters the sewer system. The plants on a green roof can also cool the air above a roof. With a significant surface area, the overall temperature of a city can be reduced (Bliss, 2004:4). And also on a city-wide scale green roofs can mitigate the urban heat island effect (UHI) through cooling due to increased evapotran- spiration thus reducing energy use and carbon dioxide emissions. They can also sequester carbon (Williams and others, 2010: 245 see also Skinner, 2006; Alexandri and Jones, 2008, Getter et al., 2009).

Iran has been slow to thought about green roofs And to date these are nearly no projects have been executed. Although fortunately, using roofs and Frontage for green space recently has been considered in

Tehran. Parks and Green space Organization in Tehran has given a plan to use of roofs and Frontage for development of urban green space in Tehran City Council that has been approved (Parks and green space Organization of Tehran, 2010). Also this Organization has explained that green roof is in order The Green's Government in Fourth Development Plan and 19 Topics of National Building Regulations in Iran (Ibid, 2010). Therefore, because of increasing public and government interests in establishing green roofs in Iran cities due to their demonstrated environmental benefits and so on, in first step the identification and investigation challenges and barriers in the development and progress of green roof and the major information gaps that needs to be researched in Iran is important.

2. Literature Review

Green roofs and vertical gardens are not new phenomena. They have been considered standard construction practice in many countries for hundreds, if not thousands of years. This is mainly because of the excellent insulative qualities of the combined plant and soil layer (sod). In cold climates they help retain heat in the building, and in warm climates they help to keep the heat out(Peck, Callaghan, 1999:11). In below figure shows a comparison of green roof types.

Table 1. A comparison of extensive and intensive green roofs.

Characteristic	Extensive roof	Intensive roof
Purpose	Functional: storm-water management, thermal insulation, fireproofing	Functional and aesthetic; increased living space
Structural requirements	Typically within standard roof weight-bearing parameters; additional 70 to 170 kg per m^2 (Dunnett and Kingsbury 2004)	Planning required in design phase or structural improvements necessary; additional 290 to 970 kg per m^2
Substrate type	Lightweight; high porosity, low organic matter	Lightweight to heavy; high porosity, low organic matter
Average substrate depth	2 to 20 cm	20 or more cm
Plant communities	Low-growing communities of plants and mosses selected for stress-tolerance qualities (e.g., Sedum spp., Sempervivum spp.)	No restrictions other than those imposed by substrate depth, climate, building height and exposure, and irrigation facilities
Irrigation	Most require little or no irrigation	Often require irrigation
Maintenance	Little or no maintenance required; some weeding or mowing as necessary	Same maintenance requirements as similar garden at ground level
Cost (above waterproofing membrane)	\$10 to \$30 per ft^2 (\$100 to \$300 per m^2)	\$20 or more per ft^2 (\$200 per m^2)
Accessibility	Generally functional rather than accessible; will need basic accessibility for maintenance	Typically accessible; bylaw considerations

Figure 1: A Comparison of extensive and intensive green roofs
Source: Oberndorfer & others, 2007: 825

The term green roof has two connotations: one is more specific, signifies a thin green layer of substrate and vegetation, not intended for human inhabitation; the other is a broad meaning that includes all forms of roof greening. Commonly, the use of the term green roof implies that the entire roof is covered with a layer of impervious membrane, which is topped with soil and vegetation in order to optimize the site-specific and community environmental benefits (Coffman, 2007:8. See also Peck and Kuhn 2001; Scholz-Barth 2001).
Any planted open space that is separated from the earth by a building or other structure can be considered a roof garden. These are most obvious well above ground level, but are also commonly found at or just above ground level, on top of structures such as underground parking garages (Kortright, 2001 see also Osmundson 1999).
The concept of roof greening has two histories: one of opulence and the other of economy. As explained by Osmundson (2001), the luxury of roof greening for wealth and power dates back to before 2000 BC. Works such as the Hanging Gardens of Babylon, the Ziggurat of Nanna. On the other hand, the thrifty use of locally available materials, such as sod, by needy individuals, to protect and insulate their dwellings, has been a part of many cultures for equally as long. Northern European cultures have conserved examples of these works as a part of national heritage sites. These examples are made of local soils and plants and placed on small dwellings to be used almost solely to cool the structure during intense heat or warm the structure during intense cold(Coffman, 2007:8 see also Osmundson,1999, Peck, Callaghan, 1999). In Iran is a notable example Masouleh.

3. Methodology

The article is studying effective factors in the development of green roofs in Iran and because various aspects the urban green roof have interaction with one another, multi-purpose analysis is used. This technique, in the form of hierarchy, provides the process of modeling a subject with different objectives and sometimes opposite and also allows us that evaluate quantitative and qualitative criteria. The first with using of opinions of professionals and different experiences and resources in this context, was queried about main dimensions of green roof development in Iran and was determined non- development factors of green roof in various aspects.

The results were 6 main dimensions as development prerequisites of green roof and determine some indicators for any main dimensions. By experts, main dimensions and also in any dimensions have been classified with AHP analysis. For AHP analysis was used Expert Choice software (in each of priorities has been accounted rate of incompatibility with the AHP method). Then the synthesis (integration) and conclusions have been constituted based on the ideal synthesis of performance and sensitivity analysis graphs that shows the sensitivity of the selections to all criteria. In the first step have been used various sources and opinion of eight experts, interested in the development of urban green space, including three PhDs student in urban planning and geography, three experts in the municipal urban green space, one landscape design faculty members and one MA in urban and regional planning. Then questionnaire, for Prioritization of the main dimensions, was designed and given to 102 environmental science experts. And Prioritization of indicators has been classified by 30 experts.

4. Result and Analysis

To date use of green roof in our country is not common, so in the beginning a basic question as most important principle in successful development of green roofs, is what is main dimensions and important sub dimensions in development green roof. As in Figure 2 and Table 2 results have been shown; respectively the financing order and economic issues, policies and organizational management, legal aspects, technical and scientific infrastructure, cultural environment and geographical environment are most important dimensions in development green roof in Iran.

Table 1: The importance and priority of each of the main criteria and the development of green roofs

Code	Dimensions	Weight	Order of importance
F1	Cultural	0/066	5
F2	Management and organization policy	0/283	2
F3	Investment	0/314	1
F4	Technical and scientific infrastructure	0/084	4
F5	Geographical	0/039	6
F6	Legal	0/213	3

There are many barriers to the implementation of green roofs in Tehran and other metropolitans in Iran. Most important subject is economical dimension. In Iran because of the low cost of Oil and tar therefore common roofs are Cheaper and more common. Green roof is not yet a part of Sustainable landscaping policy in urban management and organizational policy, and also have not regulations to encouragement and obligation the construction it. In result of people, organizations, Institutions and corporation have not motivation for it. At this stage of the industry's development would set up regulations, rules and incentives. For example, one option to encourage green roof implementation is to directly mandate in the building code that all buildings of a certain type must green all or part of their roof. Public buildings or large commercial buildings with flat roofs are often identified as candidates for this regulation. Design specifications may also be included, such as the depth of growing media, amount of plant coverage, water retention capacity, and/or roof surface reflectance. This technology standard approach has been implemented in Tokyo, Japan where private buildings larger than 1000 m2 and public buildings larger than 250 m2 are required to have 20% of the rooftop greened. Due to this ordinance, 54.5ha of rooftops have been greened in the city as of January 1, 2005. The city of Linz, Austria requires green roofs on all new buildings larger than 100 m2 and a slope of up to 20%, as well as the roof surfaces of all underground structures, such as subsurface parking decks. In response to loss of biodiversity in urban areas, Basel, Switzerland has mandated green roofs on all new buildings with flat roofs and for roofs over 500 m2, substrate composition and depth requirements are imposed (Carter& Fowler, 2008 see also Ngan 2004, Brenneisen 2006).

Of course about Iran this subject also needs to research to determine characteristics of green roof such as kind, purpose, structural requirement, substrate type, plant communities (for example as for Tehran climate they can survive periods of hot weather with minimal irrigation), maintenance, cost, accessibility, And also economical incentives and introduction successful typical. In relation to economical incentives as Carter mentions, direct economic incentives involve subsidies specifically for new green roof installations as well as for broader urban greening programs that include green roofs. Density bonuses for roof greening and stormwater fee credits are common forms of indirect economic benefits (Carter& Fowler, 2008).

However, many of the difficulties are currently preventing wide-scale construction of green roofs in metropolitans in Iran that have been shown in Table 2. But as Williams, Rayner, Raynor mention about green roof in Australia, areas with constant or seasonal hot, dry climates have the most to gain from implementing green roofs as a climate change adaptation measure (Williams and others, 2010: 250, see also Alexandri and Jones, 2008), which suggests Iran has a lot to gain if the technology can be adapted. Similarly, the risk of typical hot and dry climate green roof plant species failing could spur the identification of suitable Iran species and develop an export market for them. Once the substrate and plants required for successful Iranian green roofs are identified and developed, the environmental benefits of green roofs in Iran conditions can be evaluated and policy incentives developed to increase uptake (Derived from Williams and others, 2010: 250). Figure 2 shows sensitive analysis effective factors in green roof development.

Table 2: Results of the barriers to green roof development in Iran, the hierarchical analysis.

Symbol	Ranking	Dimensions
A		**Investment**
A1	1-1	Cost varies based on type of green roof materials and the environment than conventional roofs.
A3	1-2	Low cost of energy in Iran and the unwillingness of consumers to reduce energy costs (as insulation against cold and heat).
A7	1-3	Lack of financial resources to governmental or non-utilization of existing potentials.
A6	1-4	Different cost of maintenance of green roofs throughout the year for developers than conventional roofs.
A2	1-5	Failure to provide financial facilities to the public and private developers.
A4	1-6	Vacuum plans with economic justifications for public sector and private developers.
A8	1-7	Costs in excess of plant maintenance.
A5	1-8	Lack of information about the benefits of private sector investment in this sector.
B		**Management and organization policy**
B5	2-1	Vacuum to obtain a green roof as part of a sustainable green space, along with other policy planning and design of urban green spaces
B1	2-2	Lack of information and informing the authorities and experts and municipal middle managers on the benefits of green roofs.
B4	2-3	Development of systems and approaches in the municipalities and the Department of green space in order to resolve existing problems in the field of green roofs
B2	2-4	Vacuum symbolic public or private project on green roofs.
B7	2-5	The successful experiences of other countries in the field of green roofs.
B6	2-6	Not related to encourage consultants and contractors, and research in thisfield of research.
B3	2-7	Absence of local standards and a framework for continuous evaluation and improvement in problems over time.
C		**Legal**
C1	3-1	Lack of legal basis to encourage investment in green roof
C2	3-2	The absence of codified rules required to create a green roof (such as grammatical rules for the construction of buildings with green roof area above the foundation).
D		**Technical and scientific infrastructure**
D2	4-1	Easy to build and equip the roofs of regular and easy access to the materials.
D8	4-2	Lack of experience, knowledge and relationship with the green roof industry.
D4	4-3	Lack of local green roof industry.
D1	4-4	Equipment was not as extensive green roofs for residential buildings, apartments and business centers with different technologies.
D5	4-5	Vacuum system, the introduction of comprehensive software and hardware, consulting, and quality of information and equipment needed.
D9	4-6	Ability to cover any form of conventional roof construction.
D6	4-7	Vacuum research applications for major cities to promote green roofs and the plant species suitable for different environments.
D3	4-8	Low level of scientific data used to evaluate the different local situations.

D7	4-9	The inability of mobile water for irrigation.
E		**Cultural**
E4	5-1	Culturally normative compatibility of conventional roofs.
E2	5-2	Void space between the partnership and manage the creation and maintenance of green roofs in residential and commercial, and others.
E5	5-3	Lack of trained manpower for the operation, standardization and maintenance of green roofs.
E1	5-4	NGO strong vacuum in the field of urban environmental protection and public participation in this field.
E3	5-5	The sensitivity and importance of culture in a vacuum environment, climate and ecological urban poor and the need to improve participation in major cities And the positive impact of green roofs as a collective action.
E6	5-6	Lack of awareness about green roofs and its advantages for the environment and society through public information.
G		**Geographical**
G2	6-1	Desirability of the location
G1	6-2	Green roof void in the city or metropolitan or urban areas, some specific geographic areas.

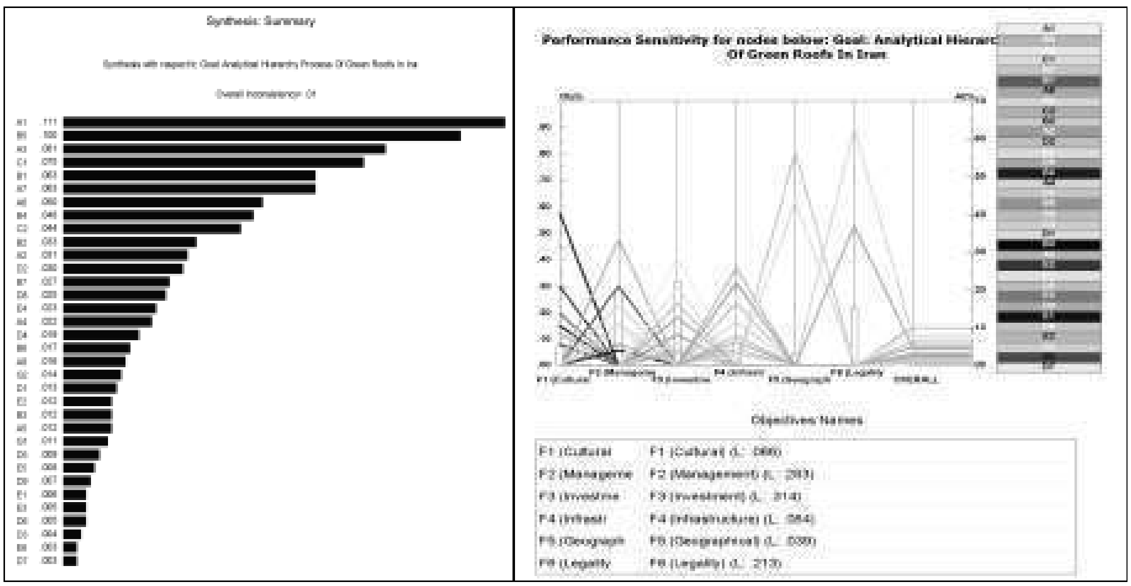

Figure 2: Sensitive Analysis

5. Conclusion

Despite the nascent nature of the industry, there has recently been a increasing interest in green roofs in Iran and the industry may experience rapid growth if the barriers to their implementation can be overcome. As Williams, Rayner, Raynor mention about green roof in Australia, policies would be approved into financial incentives likely to stimulate the green roof industry and also take the form of regulations that have encouraged the construction of green roofs in Switzerland and Germany. While the absence of policy incentives is a barrier to the widespread uptake of green roofs, policy makers are likely to be reluctant to include green roofs in building codes and planning guidelines until there is quality data assessing their costs and benefits in an Iranian context. This requires successful green roof examples which can be monitored and objectively evaluated. Many of these barriers represent fairly standard challenges facing the adoption of new technologies. Fortunately, much of the technical, policy and market-based information on green roofs is available and can be adapted. Difficulties in identifying the costs and benefits of green roofs and vertical gardens are perhaps the most difficult challenge. Tangible economic benefits are difficult to quantify and guarantee. The significant environmental and social benefits attainable, in the absence of government policy, do not find expression in the market place (Peck, Callaghan, 1999:49) that also findings of the study confirmed it.

There are a number of general categories of green roof policies which directly and indirectly encourage new green roof installations. Some policies take the form of a ‘‘command and control’’ approach through performance or technology standards while others utilize a market-based approach using tax incentives or government subsidies. When determining which type of approach to use, it is important to recognize whether the costs of implementation are homogenous across the industry or if there is a significant degree of heterogeneity. If costs are relatively similar, then a policy based on standards can be just as efficient as market-based approaches (Carter& Fowler, 2008. See also Revesz and Stavins 2004).

With the entire benefits green roof should be acknowledged the technology has not found its status because of ambiguity its social and economical dimensions. Also are affected other factors such as high administrative cost of installation, Launching proper irrigation systems, Additional costs for strengthening of existing buildings, Expenses related to maintenance and most importantly Non adequate know, non trust and guaranty to the technology. Of course these findings have conformity with a report of workshop that held in Toronto, Canada on November 24, 1998(Peck, Callaghan, 1999:41).

References

Alexandri, E., Jones, P., 2008. Temperature decreases in an urban canyon due to green walls and green roofs in diverse climates. Building and Environment 43, 480–493.

Bliss, Daniel James. (2007). STORMWATER RUNOFF MITIGATION AND WATER QUALITY IMPROVEMENTS THROUGH THE USE OF A GREEN ROOF IN PITTSBURGH, PA. Submitted to the Graduate Faculty of the School of Engineering in partial fulfillment of the requirements for the degree of Master of Science University of Pittsburgh.

Boivin, Marie-Anne; .Geld vom staat fur gurne dacher.; DZ, December 1992, in Presentation Abstract . Greenbacks from Green Roofs: Forging A New Industry In Canada, Workshop Program, Peck & Associates, November 1998.

Brenneisen S (2006) Space for urban wildlife: designing green roofs as habitats in Switzerland. Urban Habitats 4:27–36

Carter, Timothy. Fowler, Laurie.(2008). Establishing Green Roof Infrastructure Through Environmental Policy Instruments. Environmental Management (2008) 42:151–164 DOI 10.1007/s00267-008-9095-5

Coffman, Reid R. M.L.A.(2007), Vegetated Roof Systems: Design, Productivity, Retention, Habitat, And Sustainability In Green Roof And Ecoroof Technology, The Ohio State University 2007. Presented in Partial Fulfillment of the Requirements for the Degree Doctor of Philosophy in the Graduate School of the Ohio State University

Getter, K.L., Rowe, D.B., Robertson, G.P., Cregg, B.M., Andresen, J.A., 2009. Carbon sequestration potential of extensive green roofs. Environmental Science and Technology 43, 7564–7570

Kortright, Robin, (2001), Evaluating the Potential of Green Roof Agriculture, Published By City Farmer, Canada's Office of Urban Agriculture, Trent University, Coctober 2001.

Kosareo, L., Ries, R., 2007. Comparative environmental life cycle assessment of green roofs. Building and Environment 42, 2606–2613.

Ngan G (2004) Green Roof Policies: Tools for Encouraging Sustainable Design. Available at http://www.gnla.ca/assets/ Policy%20report.pdf. Accessed in December 2007

Oberndorfer, Erica, Lundholm, Jeremy. Bass, Brad, Coffman, Reid R. Doshi, Hitesh. Dunnett, Nigel. Gaffin, Stuart, Köhler, Manfred. Liu, Karen K. Y. Rowe,Bradley. (2007).Green Roofs as Urban Ecosystems: Ecological Structures, Functions, and Services. BioScience • November 2007 / Vol. 57 No. 10. www.biosciencemag.org

Osmundson, T. (1999). Roof gardens : history, design, and construction. New York, W.W. Norton. Parks and green space Organization of Tehran, 2010. http://parks.tehran.ir.

Peck, S., C. Callaghan, B. Bass and M. Kuhn (1999). Greenbacks from Green Roofs: Forging a New Industry in Canada. Ottawa, ON, Canada Mortgage and Housing Corporation: 54.

Peck, S., C. Callaghan, B. Bass and M. Kuhn (2001). Greenbacks from Green Roofs: Forging a New Industry in Canada. Ottawa, ON, Canada Mortgage and Housing Corporation: 54

Revesz R, Stavins R (2004) Environmental Law and Policy. Resources for the Future Discussion Paper 04-30-REV. Available at http://www.rff.org/rff/Documents/RFF-DP-04-30-REV. pdf. Accessed in December 2007.

Sailor, D.J., 2008. A green roof model for building energy simulation programs. Energy and Buildings 40, 1466–1478.

Scholz-Barth, K. (2001). "Green roofs: stormwater management from the top down." Environmental Design & Construction.

Skinner, C.J., 2006. Urban density. Meteorology and Rooftops Urban Policy and Research 24, 355–367.

Van Renterghem, T., Botteldooren, D., 2009. Reducing the acoustical facade load from road traffic with green roofs. Building and Environment 44, 1081–1087.

Williams, Nicholas S.G. Rayner, JohnP. Raynor, KirstenJ. (2010). Green roofs for awide brown land:Opportunities and barriers for roof top greening inAustralia, Urban Forestry & Urban Greening. Urban Forestry & Urban Greening 9 (2010) 245–251