E3S Web of Conferences **3**, 01022 (2014)
DOI: 10.1051/e3sconf/20140301022

The Perception of Malaysian Architects towards the Implementation of Green Roofs: A Review of Practices, Methodologies and Future Research

M.H. Md. Zahir[1,2], S.N. Raman[2], M.F. Mohamed[2], M. Jamiland[2], Z.M. Nopiah[3]

[1]Public Works Department of Malaysia (JKR), JKR Malaysia Headquarters, 50582 Kuala Lumpur, Malaysia.
[2]Department of Architecture, Faculty of Engineering and Built Environment, Universiti Kebangsaan Malaysia, 43600 UKM Bangi, Selangor, Malaysia.
[3]Unit for Fundamental Studies in Engineering, Faculty of Engineering and Built Environment, Universiti Kebangsaan Malaysia, 43600 UKM Bangi, Selangor, Malaysia.

Abstract. The implementation of green roofs or vegetated roof as a sustainable tool to mitigate the Urban Heat Island effect is relatively new in Malaysia. Although it has not been tested on an urban scale, many research findings have indicated that green roofs can contribute towards enhancing the environmental and aesthetical quality of the built environment. It was hypothesized that the low application of green roofs in the Malaysian construction industry is due to the lack of awareness, understanding and experience in its benefits especially among building practitioners. As a result, this research was initiated to determine the perception and understanding of Malaysian architects in green roofs implementation issues, as well as to identify their level of acceptance and readiness. This paper reviews practices and different research approaches in understanding the factors that influence architect's perception towards the implementation of green roofs in the Malaysian construction industry. Architects were chosen as the only respondents due to their intensive involvement in the conceptualisation, planning, design and construction stage of a built environment project. Extensive literature review was conducted to explore past experiences in green roof implementation and to develop the theoretical framework for this research.

1 Introduction

The global warming phenomenon has triggered the movement towards sustainability in the Malaysian construction industry. During the UN Climate Change Conference in Copenhagen, in December 2009, The Honourable Prime Minister of Malaysia has made a commitment to reduce Malaysia's CO_2 emission by 40% by the year 2020 [1]. In view of this, the Malaysian Government has created numerous green initiatives such as the National Green Technology Policy [2] and Greater KL, which plan to create a more sustainable and liveable city [3]. In order to achieve this emission target, the government have taken measures to control its urbanisation sector, which consumes most of the national energy and natural resources, generates lots of waste and emits tons of air pollutant.

The booming of urban population has generated mass development and has increased the impervious area while reducing the greenery. In 2012, a study showed that Kuala Lumpur's green

areas have been reduced to 59.4% or 14,386 hectare from its original 24,222 hectare of city area [4]. This shows that the urbanisation throughout the years has affected the Kuala Lumpur green areas, thus creating many environmental problems and creating high demand for its urban green spaces [5].This also means that the previous policies implemented did not reach their targets although measures have been taken by the local government to plant more trees and creating more green areas for urban dwellers [6].

A study by Shaharuddinet. Al [7] analysed the relation between different urban land uses and Urban Heat Island (UHI) in Kuala Lumpur. The research showed that the highest temperature was recorded at the impervious commercial and business area compared to green areas and water bodies. It also suggested that if not mitigated properly, Kuala Lumpur may have the worst UHI in the near future and could deteriorate the urban living conditions of its urban dwellers. The main strategy for reducing the UHI is to have a well-planned tree-planting program, the effectiveness of small city park and different types of vegetation as temperature moderators [8].

According to Ismail et. al [9], many buildings in developed countries have used green roof as one of the solution to increase green area along with its benefits. Around 14% of all flat roofs in Germany have adapted green roof and it became common because of the supportive government policies [10]. Green roofs were well accepted for European cities with environmental problems and less green space [11]. Getter & Rowe [12] stated that, in most urban areas, the roof area would normally represent around 21% - 26% of the total areas. It will give the opportunity to increase the urban green area if green roofs were used. To increase the urban green area, "The Greening of Greater KL" initiated by Ministry of Federal Territories and Urban Wellbeing have targeted a total area of 150,000m^2 of conventional roofs to be converted into green roofs by 2020 [13].

With the growing urban population rate of 2.4% annually, 72% of Malaysian's total population live in the urban areas [14].As a result, the government have taken measures to ensure that every citizen has sufficient green space of 16m^2 per person [13]. Since 2004, the Town and Country Planning Department (JPBD) have initiated various planning guidelines that included green roofs. These guidelines were designed specifically for industrial players such as the Local Authorities, Developers and Building Professionals [15-17].

Despite the government policies towards a sustainable urbanisation, only a handful of buildings in Malaysia have adopted green roofs [18]. Building professionals such as architect plays an important role in the development process. An environmentally concerned architect will influence and advise their client towards on environmentally positive and sustainable development. Hence, it is crucial to understand and identify the perception of local architects towards the benefits of green roofs and the obstacles in its implementation. Both of these factors are known to influence the acceptance of this technology in the Malaysian construction industry.

The objective of this paper is to discuss and deliberate on the methodologies that can be adopted to measure the current perception of Malaysian architects on the possible implementation of green roof in the local construction industry. In order to achieve this aim, the methodologies applied by past research, local and abroad, have been investigated, their findings examined and the data have been utilised to formulate appropriate tools to be used in the present study.

2 Definitions for Green Roof

As stated by Grant, Engleback [19] the term 'green roof' can be defined as either a roof top garden with ornamental planting or a fertile vegetation space, which has been designed to develop naturally, and with a substrate on a man-made structure, of at least one floor. However, Getter and Rowe [12] described green roof as a vegetated roof system with growing media, supporting layers such as root barrier, roof membrane and drainage to recover the loss of green space. This indicates that most of man-made structure with vegetation layers and habitable space beneath the structure can be considered as a green roof.

It has been recorded that green roofs have been used on the Hanging Garden of Babylon and on the Nordic Vikings houses [20] and other civilisation. Green roofs have long been associated with

sustainability, as it tends to be the best replacement for the loss of green area when a building is constructed. It is also one of the typical methods used in sustainable development principles [21]. Commonly agreed, green roofs can be divided into two distinctive groups namely, the intensive and extensive green roof [12]. Intensive green roofs have deeper soil and more varieties of vegetation, but are costly to build and maintain. On the contrary, extensive green roofs are cheaper and easier to build and maintain. It contains shallow soil, have fewer varieties of vegetation and rarely accessible unlike its counterpart.

3 Green Roof Implementation in Malaysia

For the past 15 years, only a handful of buildings in Malaysia have adapted green roof as a main green feature element [22]. From past research, some implementers were very sceptical about having rooftop gardens due to unknown risk on maintenance aspects. Although nowadays many commercial buildings have green garden on their roof or as a recreational podium, the type of green roof were mostly extensive rather than intensive.

Table 1: Implementation of Green Roofs in Malaysia

Building	Type of Green Roof	Architect	Year
Rice Garden Museum (Laman Padi), Langkawi.	Intensive	-	1998
Ministry of Finance, Putrajaya.	Extensive and Intensive	GDP Architect.	2002
Putrajaya International Convention Centre (PICC).	Intensive and Extensive	Hijjas Kasturi Assc.	2003
Putrajaya City Hall, Putrajaya.	Extensive	ZDR Architect.	2004
Malaysian Design Technology Centre (MDTC), LKW, Cyberjaya.	Extensive	Llewellyn Davies Yeang.	2004
Serdang Hospital.	Intensive	Gabungan Architect.	2005
Faculty of Social Sciences and Humanities, UKM.	Retrofit Extensive	-	2007
Sime Darby Oasis, Damansara.	Extensive	GRA Architect.	2009
KL Sentral Park @ Platinum.	Intensive	Perunding Alam Bina & Cox Architects.	2009
Newcastle University Medicine Malaysia, Nusajaya.	Extensive	MAA Architect.	2011
Laman PKNS, Shah Alam.	Intensive	Veritas Architect.	2013
Heriot-Watt University, Putrajaya.	Extensive	Hijjas Kasturi Assc.	Expected in 2014
Tun Razak Exchange (TRX).	Intensive	Arkitek Jururancang & Machado Silvetti and Assc.	Expected in 2016

Nowadays, green roofs and green facades are becoming a trend in contemporary modern high-rise design in Kuala Lumpur. An early initiative related to green roof in Malaysia started when rooftop paddy field projects was realized with the building of Laman Padi or Rice Garden in Langkawi in 1998. Since then, paddy harvesting was done up to 4 times a year [23]. Table 1 list out the timeline of buildings with significant green roof in Malaysia.

4 Literature Research

This section discuss on the methodologies employed by previous researchers in analysing the perception on green roof. Various studies have been conducted, both locally and abroad, on matters

involving building professional's perception on green roof implementation issues and have been documented in various publications [9, 20, 21, 24-27].

This article is partly an exploratory step in determining the appropriate methodologies that can be used in this study. By investigating and understanding the viewpoints of past studies, the research scope and limitations can be clearly defined. This step is crucial because identifying past methodologies will allow ascertaining the key factors for developing better results. These methodologies and its results have been summarized in Table 2 and Table 3.

Table 2: Research methods and findings on implementation issues of green roofs in Malaysia

Authors	Method(s)	Target Sample(s)	Findings on Perception
Ismail et al. [28, 29]	Using field observation on 3 green roof buildings and interviews.	3 Facilities Managers (FM) of green roof buildings.	3 FM optimistic towards green roof benefits. Lack of supervision during construction and maintenance contributes to leakages. Other problems related to unspecialized green roof designer.
Aziz&Ismail [24]	Literature Review, Survey and Case Study.	Local developers &Architects	Proposed papers
Ismail et al. [18]	Literature review	-	Proposed papers
Ismail et al. [9]	Questionnaire survey	350 Local architects	75 responses. Past failure, no design guidelines and limited local expertise on green roof are the main obstacles in implementation.

Table 3: Research methods and findings on implementation issues of green roofs in other countries.

Author	Method(s)	Target Sample(s)	Findings on Perception
Wong et al. [25]	Using mixed method of survey questionnaire and interviews	332 Singaporean architects, landscape architects, developers.	104 responses from the construction practitioners generally agreed with the benefits of green roofs. They disagreed that green roof can improve the life span of waterproofing membrane.
Taheri et al. [26]	Face-to-face questionnaire and semi-structured interviews.	40 Iranian construction professionals and practitioners	89.5% believed that green roofs are important for reducing heat and cools buildings and the environment. 97.7% believed green roofs should be implemented to reduce urban energy issues. In general they believed green roofs could improve urban climate.
House [20]	Face-to-face semi-structured interviews	8 North Texas developers, city planners, architects & landscape architects.	City officials and developers are have limited knowledge on green roof. Barrier issues on cost, unfamiliarity and lack of incentives.
Kuper [27]	Face-to-face survey questionnaire.	100 students of Temple University Ambler Campus.	Half of respondents did not know anything about green roof. Majority were neutral of having green roof in their neighbourhood. Very few had strong perceptions against green roof.

Literatures that discuss on the perception towards green roofs in Malaysia were very limited. These articles used both qualitative and quantitative methods towards construction practitioners such as architects, facility managers, developers and other built environment professionals. These authors have also identified various literatures from overseas that included varied groups of building professionals and practitioners in their study. The wide range of building professionals creates a more

comprehensive research on the subject matter. Research by Ismail, et al. [29] emphasizes on the maintenance aspect of green roof and explores the benefits and outcome in the post-construction period. The samples used in this study were all facilities managers that maintained the green roof buildings. These samples offered a different kind of end results than the pre-construction and during-construction samples. Ismail et al. [9] used different methods to collect the architect's perception only on green roof obstacles. From the literature, he listed nine obstacles to be ranked by the respondents and the results were then analysed using the relative importance index (RII) formula. It was concluded that the biggest obstacles was perceived on limited of local expertise and inexperienced green roof applicators.

Investigation by Aziz& Ismail [24] summarised all the conclusion and factors associated with green roofs obstacles, benefits and guidelines. From these findings, Aziz and Ismail [24] proposed a survey on two target samples, namely developers and architects in the Malaysian construction industry. Meanwhile, Wong et al. [25] used a mixed method of survey questionnaire and interviews of architects, landscape architects and developers in Singapore. Mean rating and t-value were used to gauge the sample's perception on the beneficial and obstacle factors. Interviews were conducted on ten professionals that implement green roofs. Both qualitative and quantitative results were used to cross verify each other.

Taheri et al. [26] used face-to-face interviews with structured questionnaire on 40 Iranian built environment professionals. The survey included 8 different samples, i.e. landscape architects, architects, urban planners, civil engineers, horticulture engineers, municipal managers, professional academicians, and environmental experts. The goal from this research was to gauge their perception and at the end to strategize a municipal policy for green roof. It emphasised 3 questions that were related to the benefits of green roof towards the environment, social aspects and suitability of roof surface for green roof retrofitting.

House [20] used face-to-face semi structured interviews with open-ended questions, which focused on 4 kinds of samples, developers, city planners, architects and landscape architects. Voice recording and thematic analysis were used to capture the pertinent issues, their understanding and perception on green roof implementation in North Texas. The results covered a wide range of different scope of work during pre-construction period mainly on designers, planning approval authority and the builders themselves. This approach will be used in the present study to cross verify the results in quantitative survey but the scope will be limited to architects. The methodologies adopted by past research both locally and internationally, had a number of similarities:

i. Most of them used basic method of either a qualitative or a quantitative or a mixed method.
ii. The results showed that majority of respondents were positive in the benefits of green roof regardless the size of the sample.
iii. The results indicated that many building practitioners have similar green roof implementation issues.
iv. The targeted samples were built environment individuals with aims to gauge their perception and understanding on green roof issues.

5 Findings and Discussion

Based on the review on methodologies and their findings, the author decided to use a mixed method survey questionnaire, case studies and interviews in the present study to measure the perception of local architects registered with the Board of Architects, Malaysia (LAM), and with a balanced distribution of graduate and professional architects. Architects were chosen as the respondents due to their close involvement in the conceptualisation, planning, design and construction of a built environment project. Based on similar methods as employed by Wong et al. [25], survey questionnaire will be sent out to 2500 architects all over Malaysia while interviews will be conducted on 5 architects who are responsible for the implementation of green roofs in their projects. Based on the recommendation by Krejcie and Morgan [30], the target sample size for the said population in this study will be $n = 333$ respondents. Questions will be divided into five sections which identify their

age, sex, working experience, academic and professional background, their level of experience and understanding on green roof, perceptions on the benefits and obstacles of green roof, and ways to promote the technology. Open-ended questions will also be asked to determine other relevant issues and ideas to promote the implementation of green roofs. Statistical SPSS analysis will then be used to identify the correlations of the sample background and their preferences, and how they react.

To identify the respondent level of understanding on the benefits of green roof, they will be asked to rank on the 10 beneficial factors of using it in construction, regardless their knowledge and experience level. These beneficial factors, as well as the obstacles or barriers in green roof implementation, have been derived from the literature review by Ismail et al. [9], House [20], Wong et al. [25] and Aziz and Ismail [24]. The 10 identified beneficial factors of green roof are listed below:

i. Increase the roof life span by protecting it against the sun's direct heat.
ii. Increase the aesthetics and economic values of properties.
iii. Reduce the Urban Heat Island Effect.
iv. Restore the ecosystem of flora and fauna into the urban.
v. Gain recognition and certification through Green Building Index (GBI).
vi. Reduce water surface runoff and urban flood.
vii. Reduce a building cooling load and CO_2 emissions.
viii. Create urban green spaces for social activities and agriculture.
ix. As a buffer zone from noise and air pollution.
x. Reducing the Roof Thermal Transfer Value (RTTV).

The barriers in green roof implementation on the other hand can be categorised into 9 significant issues, which are as listed below:

i. Many local architects are not convinced of the benefits.
ii. Lack of policies and guidelines on green roofs and furthermore the government has not imposed it in the Building By-Law.
iii. Implementation constraints from the client and the difficulties to convince them.
iv. Technology is still new and the lack of supply has raised the cost of installation and maintenance.
v. Lack of expertise in green roof technology.
vi. Contributes to leakages, shorten the roof life span and impose more loads to the building structure.
vii. Concerned about the unknown risk.
viii. Local architects do not play the role to encourage the use of green roof.
ix. Lack of demand in the Malaysian construction industry market.

Field observations and case studies will also be conducted on local buildings with green roof features to cross verify the quantitative data based on methods used by Ismail et al. [9],House [20] and Ismail et al. [29].These case studies will be conducted on three local building that are already equipped with green roof, while another two buildings during their construction stage, to compare the implementation issues faced by architects. Observation method will be verified with interviews with the architects involved on these buildings. Meanwhile, thematic analysis will be used to analyse the open-ended answers.

6 Conclusions and Recommendations

The different types of methodologies used to measure the perception of building professional on green roof implementation issues have created new perspective in its acceptance around the world. The change towards green concepts in the construction industry has become a global trend. This paper emphasized on the methodologies that will be employed in this study to determine the perception of Malaysian Architects towards the implementation of green roofs in the local construction industry. Findings from this research are a continuation from past research and needs to be explored in terms of ways to overcome the barriers faced by local architects. It is recommended that future research should

not only emphasize on finding ways to promote green roof among all building professionals, butalso suggest improvements to existing policies, guidelines and green roofs campaign in Malaysia.

Acknowledgments

This research was funded through the Fundamental Research Grant Scheme (FRGS/1/2012/TK07/UKM/03/3) of Ministry of Education of Malaysia; and the GGPM Research Grant (GGPM-2012-029) of Universiti Kebangsaan Malaysia.

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