PROBABILISTIC COST-BENEFIT ANALYSIS OF INSTALLING EXTENSIVE GREEN ROOF IN MALAYSIA

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To my beloved mother, father, sister and
dear Sanaz

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ABSTRACT

Green roofs have been known as an environmentally friendly application and a sustainable approach in the developed countries such as: Germany, United States and Canada. Although environmental cost-benefits related issues of green roofs are already proven by many researchers in developed countries, it is not used widely in developing countries like Malaysia. It is estimated that the market at first focuses on extensive green roof due to the lower initial and maintenance costs; as a result, a probabilistic cost-benefit analysis for extensive green roof is conducted in this study. Installation, maintenance, and disposal costs of extensive green roof system are compared with the related private and social benefits (increase of property value, savings for air conditioning, longevity, air quality improvement, carbon reduction, etc.), determining two indicators: the Net Present Value (NPV) and the Pay Back Period (PBP), using Monte Carlo simulation. The analysis demonstrated that green roofs are not long-term investments in terms of net returns. In general, installing extensive green roof is a low risk investment. Furthermore, the probability of profits out of this application is much higher than the potential financial losses.

ABSTRAK

Bumbung hijau telah dikenali sebagai satu aplikasi yang mesra alam, dan sebuah pendekatan yang mapan di Negara – Negara maju seperti : Jerman, Amerika Syarikat dan Kanada. Walaupun isu berkaitan kos faedah persekitaran bagi bumbung hijau telahpun dibuktikan oleh ramai penyelidik di Negara maju, ianya masih belum digunakan secara meluas di Negara membangun seperti Malaysia. Adalah dianggarkan bahawa matlamat utama pasaran untuk bumbung hijau sepenuhnya hanya menumpukan kepada kos permulaan dan penyelengaraan yang rendah; hasilnya, satu analisis kos-faedah kebarangkalian untuk bumbung hijau sepenuhnya telah dijalankan dalam penyelidikan ini. Kos pemasangan, penyelengaraan dan pelupusan bagi bumbung hijau sepenuhnya dibuat perbandingan dengan faedah berkaitan swasta dan sosial (peningkatan nilai hartanah, penjimatan penyaman udara, ketahanan lama, peningkatan kualiti udara, pengurangan karbon, dan lain –lain), menentukan dua penunjuk: Net Present Value (NPV) dan Pay Back Period (PBP), dengan menggunakan simulasi Monte Carlo. Analisis menunjukkan bahawa bumbung hijau bukan satu pelaburan jangka-panjang dari segi jumlah pulangan bersih. Secara umum, pemasangan bumbung hijau sepenuhnya ialah satu pelaburan risiko rendah. Tambahan pula, kebarangkalian keuntungan daripada aplikasi ini lebih tinggi daripada potensi kerugian perbelanjaan.

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CHAPTER 1

INTRODUCTION

1.1 Sustainable Designing and Development

Nowadays, sustainability is a crucial issue all around the world and governments have found the necessity of energy saving for next generations, as a result, they try to find out some solutions to reduce energy consumption. Indeed, sustainable development, is a review on modernism and tradition and also the interaction between them. Sustainable development has been expressed in Norwegian meeting as “a development to provide our requirements without any reduction for next generation” (D’Orazio, et al., 2012).

According to this statement, sustainable development, is a development in a scale of responding to human requirements without disturbing the facilities that have potential capability of providing next generations requirements. Since, sustainable designing is an intersection between human and virgin nature which try to innovate some solution to find a balance between environmental, social, and economical targets to increase the life quality of futures.

In contemporary architecture, changes according to climate circumstances and sustainable issues is becoming more popular and it is not just for sustainability of building's shell, and it could be occurred as an integrated totality for earth and energy sources.

One of the most important parts of a building is roof and many wastages of energy is related to this part. there are many introduced solution due to solve this problem but, we can clearly see the increasing public, industry and government interest in establishing green roofs in many cities due to their demonstrated environmental benefits.

Green roofs can be classified as intensive and extensive roofs based on their purpose and characteristics. Green roofs are built with different layers and variable thicknesses depending on the roof type and/or weather conditions. Basic layers, from bottom to top, of green roof systems usually consists of a root barrier, drainage, filter, growing medium, and vegetation layer.

1.2 Background of Study

In a study, (Jaffal, et al., 2012) emphasized that green roofs are considered to be an effective contribution to the resolution of several environmental problems at the building and urban levels and have several environmental benefits, such as improving building energy efficiency. In addition to the creation of a pleasant environment, green roofs offer several benefits in comparison to conventional roofs. They improve stormwater management as well as reduce air pollution and noise. Green roofs increase vegetal and animal biodiversity in cities, and they also reduce a city's carbon footprint by converting carbon dioxide to oxygen through photosynthesis.

There are different green roof systems available in the market to supply for different weather conditions and user expectations. Usually, green roofs have, from bottom to top, a root barrier, drainage, filter, growing medium, and vegetation. Manufacturers use worldwide-produced polymers, like low density polyethylene (LDPE) and polypropylene (PP), due to their easy installation, high strength, durability and low production cost. Generally, recycled LDPE is used to manufacture the root barrier, and recycled PP is used to manufacture the water retention and drainage layers.

These plastics improve the performance of green roof systems, reduce cost and overall weight of the system; however, their use as green roof layers has a socio-environmental cost. Green roofs take on average 25 years to balance the pollution released to air due to the production process of polymers. Thereby, reusing waste materials can reduce the green footprint of vegetative roofs. Responsible construction management requires quantitative estimates of costs and benefits of the alternative uses of the environment. (Carter, et al., 2008), and (Clark, et al., 2008) have proven the economic advantages of green roofs. However, a lifecycle benefit-cost value representing a unit of area of a green roof is proven by (Bianchini & Hewage, 2012).

1.3 Problem Statement

Currently, sustainability is a crucial issue all around the world and governments have found the necessity using sustainable approaches for the next generations. Green roofs are accepted as sustainable construction practice and as it can be seen in developed countries like European countries and US, there are ample installed green roofs from all types (Cantor & Steven , 2008). Although Malaysia has a significant potential of using this environmentally friendly application, it is not used widely in this country.

It is difficult to find reliable data to estimate and do the cost-benefit analyses. Investigating on cost-related issues is the first step in using a new application and the result of economic-feasibility could play a critical role in decision making about usage or rejecting that application, however, it may have many environmental advantages.

However, myriad of benefits of green roofs are proven in Malaysia (Musa, 2006), clients developers and contractors are not enthusiastic to use of this this alternative as conventional roofs and the most important reason could be the shortage of economic type of researches in two types of green roof; as a result if someone doesn't know about costs and benefits of using an application, rarely will change his mind to use an alternative instead of a proven construction practice.

1.4 Scope of Study

In order to achieve the objectives appropriately, each study must be limited on specific scopes. This research is not an exception from this rule too. Green roofs carry a large number of environmental benefits that could be appropriate for tropical climates with rainy weather. This study focuses on factors affecting on economic feasibility of extensive type of green roof in Malaysia. In this study, all the critical data is related to Malaysia and due to lack of literature in some fields, some of them gathered from reliable sources.

1.5 Aim and Objectives

The aim of this study is to investigate the economic-financial feasibility of installing extensive green roof with probabilistic cost-benefit analysis in Malaysia. To achieve these aims following objectives have determined:

1. To identify both personal and social factors affecting on economic feasibility of extensive green roof in Malaysia.

2. To calculate the NPV investment of extensive green roof considering personal and social costs and benefits.

3. To indicate the payback period of installing an extensive green roof in Malaysia.

1.6 Significance of Study

Nowadays, taking the advantages of sustainable approaches is a crucial issue for developing countries and green roof is no exception. As it can be seen in developed countries like European countries and US, there are ample installed green roofs as a sustainable application and different types of green roofs are being constructed. Although Malaysia has a significant potential of using this environmentally friendly application, there is no research that has been conducted on economic-financial feasibility of installing any types of green roof. It is obvious that economic issues play a critical role in the first step of investigating in feasibility of using a new application. This study is conducted to illustrate all the personal and social costs and benefits to

generate a new insight into cost-related issues of using green roofs in comparison with conventional roofs for investors.

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