Hospital Green Roof Management: An Interdisciplinary Review

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Review of Integrative Business & Economics Research

ABSTRACT

In 2016, the collapse of green roof at a university in Hong Kong has aroused the public concerns and given a warning signal to all buildings with similar system. It is suspected that vegetation placing on top may result in the overloading of the green roof. Similar structures are present in hospitals of different countries with hundreds and thousands of patients hospitalized in the same building. The structurally capability and legality of rooftop holding vegetation has been widely discussed in the public but little suggestions have been provided to the hospital green roof system in Hong Kong, especially relating to economic, environmental, health and safety management. Such knowledge gap in green building management had been addressed in this study. A comprehensive literature review had been performed which identified the common patterns of benefits for green roofs including the aspect of sustainable neighbourhood in reducing environmental impact, improving the wellbeing of people, and solving the problems of building energy and roof aging. Common drawback identified included the risk of structurally incapability. Findings of studies have filled the knowledge gap of hospital green building management especially on green roof system in Hong Kong, focusing on the aspects of economic, environmental, health and safety.

Keywords: hospital, green roof management, economic, environmental health and safety

1. INTRODUCTION

Green Roofs started thousands of years ago in Romans, Persians, Greeks and other cultures. People built roof gardens to cool the hot landscapes. (Snodgrass & Snodgrass, 2006) Green roof is a continuous surface of vegetated space structurally integrated with the plants not located on the ground. Green roofs can be located on top of the building; of podium deck type or as 'sky garden' on intermediate floor of the building but not on the ground level. The vegetation is either Intensive with wide plant range, with deep soils, for recreational use or of narrow plant range, extensive with lightweight soil that needs minimum maintenance cost.[1]

[1] See Architectural Services Department, 2007. *Study on Green Roof Application in Hong Kong.* [online] Retrieved from: http://www.devb.gov.hk [Retrieved on 20 September 2016].

ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

In 2007, school based green roof projects have been organized in Hong Kong, by government and business organizations, with the commitment to environmental protection. The programme provided green outdoor classrooms in schools for better learning of greening and environmental protection. Teaching materials of school green roof have been developed by university professor. Since then, secondary school students learn different aspects of soil and plant properties, and how to maintain green roof in school (Jim, 2010).

Green roof education in Hong Kong is mature through green roof school programme. It is not surprised that intensive green roofs are common. Green roof system is common in hospitals of different countries. However little information have been provided to the hospital green roof management in Hong Kong, especially in the economic, environmental, health and safety points of view. Such knowledge gap needs to be addressed in this study.

2. RESEARCH METHODOLOGY

Research methodology is the way to approach problems for finding answers. Qualitative research study how people think and act in the daily lives (Taylor & Bogdan, 1998). Application of qualitative methods in social research started in the nineteenth centuries. Qualitative research seems to promise the avoidance of statistical techniques of quantitative methods used in survey research, nevertheless it works best for many researchers, produce good pieces of research suitable for its purposal (Silverman, 2005). Qualitative research is characterized by generating words instead of data for purpose of statistical analysis, while quantitative research is characterized by applying statistics of data for drawing conclusions (Clegg, 1998).

In this study, qualitative research is used for understanding some aspect of life, such as the environmental, health and safety perspectives of hospital green roof system. The findings will be suitable as a reference for generating hypotheses and designing the surveys for quantitative methods in further studies in hospital green roof system.

2.1 Research Question

In this study, the research question is identified to be:

Are there significant economic, environmental, health and safety implications of green roof system in the hospitals of Hong Kong?

2.2 Aim

ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

To address the knowledge gap in green building management of the hospital green roofs in Hong Kong, especially in the economic, environmental, health and safety points of view.

2.3 Objectives

There are two objectives for this study:

2.3.1 To identify the common patterns of benefits and drawbacks for green roofs.

2.3.2 To identify the existing situation of hospital green roof system in Hong Kong, especially in the economic, environmental, health and safety points of view.

2.4 Research Designs

Two scientific methods exist in qualitative research distinguished by the ways of using theory in research, namely the deductive and inductive qualitative research. The deductive qualitative researchers usually start with a theory for deriving the hypotheses for testing. Observations are then made to see whether they confirm the hypotheses. The inductive qualitative researchers start with a set of observations. With curious about some theories or relationships exist, arrangements are made for collecting some relevant data. A pattern will be looked for, if exist, which best explained or summarized the observations and the conclusion(s) will then be made (Rubin & Babbie, 2008).

2.4.1 Inductive Qualitative Study

An inductive qualitative study was designed in the form of literature review. Conclusions were made based on the findings and patterns identified in the study. Reference was made from a qualitative research guide obtained online to act as a map of our study in developing the qualitative research designs.[2]

2.4.2 Time Scale

The research had taken six months to complete, from the start of data sampling to the end of paper writing.

2.4.3 Dissemination

[2] See Medecins Sans Frontieres, 2007. *A Guide to Using Qualitative Research Methodology.* [online] Retrieved from: http://fieldresearch.msf.org [Retrieved on 23 September 2016].

ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

The conclusions of the study will be disseminated at the conference and the target audience will include the governments; nongovernmental organizations, international institutions of the local and global community.

2.4.4 Sampling

A sample is a portion of the population selected for analysis in the study, whereas the population consists of all the members of the group of concern intending to draw the conclusion (Levine & Krehbiel, 2008). Samples should be representative of the population to whom results are generalized (Coolican, 1994). Besides, choosing an appropriate sample size is crucial for the research design (Petrie & Sabin, 2000). Samples in this research were obtained in a systematic way to increase the credibility.

Statistical representatives are not usually applied in qualitative research but purposive samples were selected. Samples were chosen in a systematic way for purpose of providing useful data. This was performed by ensuring the target groups of samples were included. In this study, the method of 'maximum variation sample' was used which means that the factor of demographic variable affecting the result of study was eliminated. A Sample Grid was used to prevent sample bias and include significant target groups of samples with different variables. In such a way the limitation of study was minimized through obtaining an adequate range of samples. Sample sizes are relatively small for qualitative research.

3. FINDINGS

Literature search for key texts concerning hospital green roofs had been performed online for a total of 60 samples for different online journals, conference papers, and web pages including reports, documents, case study reflective notes, etc. Common patterns of benefits and drawbacks for hospital green roofs system were identified in the data analysis.

Common patterns of benefits identified included the aspect of sustainable neighbourhood in reducing environmental impact and 'urban heat island effect', better green spaces and air quality and improving the wellbeing of people, as well as solving the problems of building energy and roof aging in the economical point of view. Common drawbacks identified for green roofs included the risk of structurally incapability and establishing the unnecessary native habitats for harmful bugs and animals.

Hospital green roof systems are common in the European and American cities. They are less common in Hong Kong and Asian hospitals. The existing situations of hospital green roof system in Hong Kong, especially in the economic, environmental, health and safety aspects were identified. It was found that green roofs in Hong Kong were present in some open public spaces but extensive green roofs in the hospital

ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

settings was limited.

4. CONCLUSIONS AND DISCUSSIONS

Green roof systems are common and mature in the European and American cities. The benefits of green roofs such as better green spaces and air quality, and lowering temperature in the buildings, saving electricity economically, moderate the 'urban heat island effect' are well understood. Jim (2008, pp142-144) states that the advantages of such roof greening include facilitating the public access to green space, especially in congested urban areas in different countries with shortage of ground level green spaces. Besides, rooftop garden is far from the streets and exempted from most problems of traffic noise and pollutants. Vegetated rooftops are claimed to filter particulate matter and absorb gaseous pollutants in air; cut down the costs of providing air conditioning, protect the drainage systems for stormwater and clean the rainwater.

Hong Kong is famous as a high-density compact urban city in the world, with limited flat lands for roads and buildings. Spaces are devoted to roads and buildings, without enough spaces for greening purpose. Intensive green roofs are common, especially built in podium garden, however with the extensive green roofs not well-established. Besides, there is a need for well-established standards, guidelines and techniques such as audits and periodic checking protocols for green roof systems in Hong Kong.

The role of hospital is to provide health services for public. (Marcellia & Hana, 2017) Hospital green roof systems in Hong Kong are less common as compared with other countries. There are significant economic, environmental, health and safety implications of green roof system in the hospitals. Much energy has been spent in providing cooling and heating devices in the hospital settings. It is found that hospital green roof systems in Hong Kong have the benefits of protecting the building roof; conserving energy such as preventing the ‘urban heat island effect’; providing the healing and relaxing environment for patients; establishing the service of horticultural therapy in the hospital green roofs; and improving the social health and wellbeing of both patients of hospital staffs. On the negative side, it arouses the environment hygiene concerns arising from establishing unnecessary native habitats for harmful bugs and animals imposing unnecessary risks to the patients. Besides, there are safety concerns to patients such as structurally capability and legality of green rooftop.

The implication of pests to the environmental and health needed to be considered. For example, pests weaken plants through transmitting diseases and make them vulnerable. Besides, failure to remove damaged stems and leaves; and overwatering of plants allows the bacteria to thrive. Remedial actions such as isolating or removing the diseased sections are needed (Brookes, 1996). Overcrowding of plantings in green roof will breed disease endangering the patients. It is important to allow light and air

ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

to get reach of plants. Safe insecticides can be applied to plants with the problems of bugs (Thomas, 1992).

The safety consideration of vegetation placing on top resulting in the overloading of the green roof should not be underestimated. Without the assistance of seeds and flowers, new plants can still be formed. Many types of plants have the ability to increase in numbers through separation and growth of different parts of the plants. For example, most creeping plants touching favourite soil will have their stems that put out root. Such rooted parts will then form new plants after separating from their parent plant. Besides, there are plants giving rise to buds after fall off, thus taking root and grow into new plants once the buds are washed to some distance. Good green building management should observe such risk of overloading the green roof due to vegetative reproduction of fast-growing vegetation placing on top (Dempsey, 1974).

The greening of cityscape, cooling of urban landscape, energy saving and life-enhancing value provided by green roofs should be supported. In the hospital there will be savings on building energy and maintenance cost for roof membrane. Besides, it is the best way for utilizing the wasted resource of vacant roof space (Pledge, 2005). It is suggested that the environmental, health and economic advantages of hospital green roofs to both their buildings and the neighbouring community outweigh their disadvantages. There is a good potential for the future development of hospital green roofs in Hong Kong.

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ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)