Creating a Decision Making Tool

HOW TO DECIDE IF ONE WILL BENEFIT FROM A GREEN ROOF

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CREATING A DECISION MAKING TOOL: HOW TO DECIDE IF ONE WILL BENEFIT FROM A GREEN ROOF

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Why is it necessary to provide a decision making model? Why do we feel the need to make rational decisions? The major goal in researching this topic is to provide data which architects can use to illustrate to their clients the most logical decision for the given instance. Rather than a client making important decisions based on hear-say evidence, information can be gathered to create a decision making guide, which will point to a clearly prominent solution.

INTRODUCTION

Although the common person often acquires the capability of making a decision based on logic, decision making tools can guide them by providing all the information on which the preferred solution is based. Tidbits are often overlooked or just plain forgotten in a typical decision making process. Creating and using a decision making matrix helps to minimize the missed items as well as introduces a mathematically based decision making process that can aide in any decision.

This research was approached with the goals of introducing this decision making matrix into the discussion of whether or not to implement a green roof into a building design. Architects hold the responsibility to communicate accurately their understanding of the decisions to be made, to the client or owner. This client-architect relationship is a vital source of the decision making process. The architect uses his/her best judgment to encourage an owner to utilize certain design components. Although some decisions are as easy as selecting one brand name over another, key decisions can completely change the outcome of a building by its impact on the surrounding environment and people as well as the amount of time the building can pay its owner back.

The decision of whether or not to implement a green roof system is of the key decisions that may alter these impacts greatly, thus the decision matrix process should be as accurate and complete as possible.

BACKGROUND INFORMATION

A decision matrix is an arrangement of qualitative or quantitative values in rows and columns that allow an analyst to systematically identify, analyze, and rate the strength of relationships between sets of information. Elements of a decision matrix represent decisions based on certain decision criteria. The matrix is especially useful for looking at large numbers of decision factors and assessing each factor"s relative importance. Decision matrix is used to describe a multi-criteria decision analysis (MCDA) problem. An MCDA problem, where there are M alternative options and each need to be assessed on N criteria, can be described by the decision matrix which has M rows and N columns, or M × N elements, as shown in the following table. Each element, such as Xij, is either a single numerical value or a single grade, representing the performance of alternative i on criterion j. For example, if alternative i is "car i", criterion j is "engine quality" assessed by five grades {Excellent, Good, Average, Below Average, Poor}, and "Car i" is assessed to be "Good" on "Engine Quality", then Xij = "Good". These assessments may be replaced by scores, from 1 to 5. Sums of scores may then be compared, ranked, to show the winning proposal.

Table 1.1

Example of Comparison				
	Criterion 1	**Criterion 2**	**...**	**Criterion N**
Alternative 1	x_{11}	x_{12}	...	x_{1N}
Alternative 2	x_{21}	x_{22}	...	x_{2N}
...	...	...	X_{ij} = Good	...
Alternative M	x_{M1}	x_{M2}	...	x_{MN}
Sum				
Rank				
Status	To copy	No	To merge	No

PRE-DECISION GUIDELINES

There are many different persuasive arguments for implementing green roofs, as these opinions should be considered, decision making should closely look at the facts presented by any case. Guidelines should first be considered to determine if implementing a green roof is a viable option. It is crucial to comprehend the process of installing a green roof in the instance of retrofitting a green roof on an existing building as well as incorporating one into a new design.

The first step for an owner is to distinguish the purpose of having a green roof, and to ensure that the green roof fits into both the owner‟s needs and their budget. Green roofs present an aesthetically-pleasing atmosphere to company employees for breaks and meetings. Hospitals and health facilities exploit the therapeutic advantages of green roofs. These facilities may use gardening as an instrument to boost the healing process for patients. Additionally, the patients can benefit from the comfort, fresh air, and landscape during their healing process.

Businesses construct green roofs to decrease the expense of energy consumption and roof maintenance. Green roofs insulate and shield structures from elements such as U.V. radiation, which decreases energy consumption and lengthens the life span of the roof. Green roofs present partial solutions to multiple environmental concerns, likely to take place in urban locations such as: storm-water management, reduction of pollution, improved air quality, reduction of „urban Heat Island Effect‟, decreased noise pollution, and quality habitats for insects and birds due to less available green space on the ground.

Establish if the green roof will be retrofitted on an existing structure or implemented to a design. Roof repair or replacement time presents a great opportunity to weigh the options of a green roof. The constructing of a green roof on a new building can double the roof membrane‟s lifespan and decrease energy costs and consumption.

Obtain required permits from the Department of Construction and Permits. Because climate, zoning, and building codes can differ from one city to the next, so can the permits required for constructing a green roof. There are cities in the US such as Portland and Chicago that offer incentives for implementing green roofs to encourage sustainable green building. These incentives may make the possibility of obtaining a green roof more achievable.

The structural loading that the building can handle determines the type of green roof. Structural engineers and architects can help an owner decide which type of roof system best fits their building regarding the structural analysis. With a soil depth from one to six inches and weight load of fifteen to fifty pounds per square foot, extensive green roofs are much lighter than intensive green roofs. Intensive green roof systems range from six to twenty-four inches of soil depth with 80-150 pounds per square foot weight load.

Green roof plants are chosen by the type of green roof, soil depth, load capacities, climate, type of irrigation system, and the height and slope of the roof. For extensive green roofs, plants such as sedums and prairie flowers are used due to their low height, will not be disturbed by nesting birds, involve minimal maintenance such as weeding and watering, and are able to withstand most of the elements presented by nature such as wind and wide range of temperatures.

Intensive green roofs tolerate a wider variety of plants such as hardy perennial, native flowers, shrubs, and even trees. Plants such as these involve maintenance including weeding and watering on a regular basis.

The type of irrigation system is dependent on the type of green roof selected. Green roof installers are typically educated in the different installation processes, and irrigation specialists are also available to design and install the necessary watering system. The irrigation systems are determined by the type of green roof, climate, and type of vegetation planted.

The initial costs of installing a green roof are higher than those of a conventional roof. But, the long-term benefits and the energy usage savings may provide an argument against taking the inexpensive route. The cost of the green roof depends on the design, climate, and plant selection. As a rough estimate, extensive green roofs can be expected to cost 8-20 dollars per square foot, while an owner may expect to pay 15-25 dollars per square foot for an intensive roof system.

The costs will usually include:

Consultant fees: Structural analysis, designers, landscapers, and contractors fees

Structural analysis recommendations: Safety and repairs needed before installation of green roof.

Irrigation system: Drip system or sprinkler and drainage costs

Garden materials: Growing medium, plants, fertilizers, substrate containers, and pavers to prevent spread of fire and allow accessibility.

Plants:

Maintenance: Initial (*extensive green roofs*) and sometimes long-term (*intensive green roofs*) maintenance costs depending on the size and type of green roof installed. For example, extensive green roofs regular maintenance is only needed for 6-12 months (after plants are established) after which watering a weeding once a season is sufficient.

Transportation of materials and services: Based on the location and types of materials

Professional assistance and permits: The zoning and building codes are different in every city.

DISCUSSION OF PROCEDURE

The first step in creating a decision matrix is to determine the alternatives and the criterion. In the green roof decision making matrix the following alternatives were chosen:

- Intensive Green Roofs
- Extensive Green Roofs
- Ethylene Propylene Diene Monomer (EDPM)

The criterion is among the most important information in the early stages of the matrix, the following criteria have been selected:

- Reduction in building energy use – The amount of energy the building requires maintaining a comfortable atmosphere for its inhabitants.
- Cost of maintenance – The cost to maintain the roof including regular maintenance and complete replacement cost.
- System life – The life span of the roof.
- Cost of construction – The initial cost of constructing the roof
- Reduction in storm water runoff – The rate and quantity at which storm water leaves roof.
- Psychological impact – The affect the roof has on the well-being of the building‟s inhabitants.

The next step of defining a weighting system is perhaps the most influential when it comes to setting up the decision matrix. Extruding from the list of criterion and determining a weight for each criteria aide in defining the importance of the different criterion. For the green roof matrix, the criteria have been ordered with the following weights:

1. Psychological impact
2. Reduction in storm water runoff
3. Cost of construction
4. System life
5. Cost of maintenance
6. Reduction in energy use

A major concern in the selection of roof type is cost and return on investment (ROI). Because the roof is not actually creating an income, the term ROI will be replaced with "savings by comparisons" for the study of green roofs. In order to take monetary impacts into consideration, two separate rating scales are being used. First, criteria which do not affect the owner financially are based on a direct placement. For example, in figure 1.2, the psychological impact row is rated as 1, 2, and 3. The criteria that was affected by the decision financially, was rated with "savings by comparison" influencing the inflation of the rating. For example, in figure 1.2 the construction cost row is rated as 1, 3, and 5. The high rating of five is based on the significance of the monetary benefits.

Table 1.2 Green Roof Decision Matrix

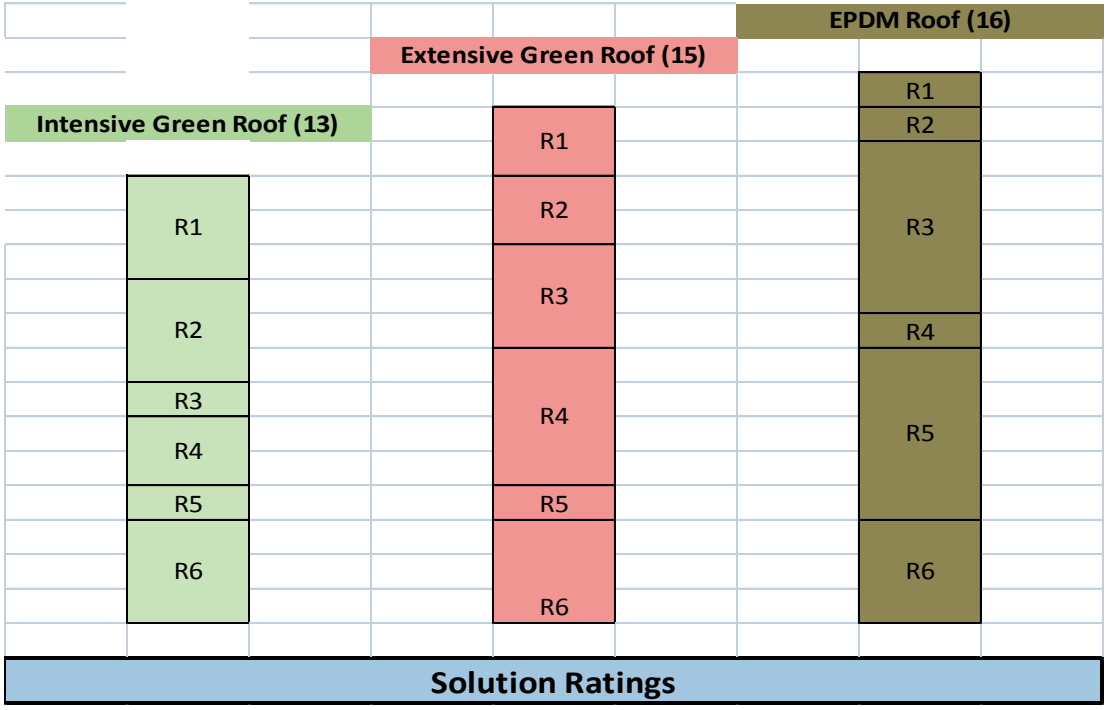
		ALTERNATIVES					
		Intensive Green Roof		Extensive Green Roof		EPDM	
CRITERIA	Weight	Rating	Score	Rating	Score	Rating	Score
Psychological Impact	1	3	3	2	2	1	1
Reduction in Storm Water Runoff	2	3	6	2	4	1	2
Cost of Construction	3	**1**	3	**3**	9	**5**	15
System Life	4	**2**	8	**4**	16	**3**	12
Cost of Maintenance	5	**1**	5	**1**	5	**5**	25
Reduction in Building Energy Use	6	**3**	18	**3**	18	**1**	6
Total	21	13	**43**	15	**54**	16	**61**

In this scenario, a higher weight value has a higher impact on the scoring system. This proves to be the only aspect of the matrix which is subjective in nature. Thus, should be the only information which the client should have to interpret. Although the listing of the criterion can be difficult to narrow down, it is possible to create multiple lists that incorporate different scenarios. For instance, if an owner cannot decide whether it"s more important for him/her to have a longer system life or a lower cost of construction, the matrix can be modified to produce both scenarios.

RESULTS

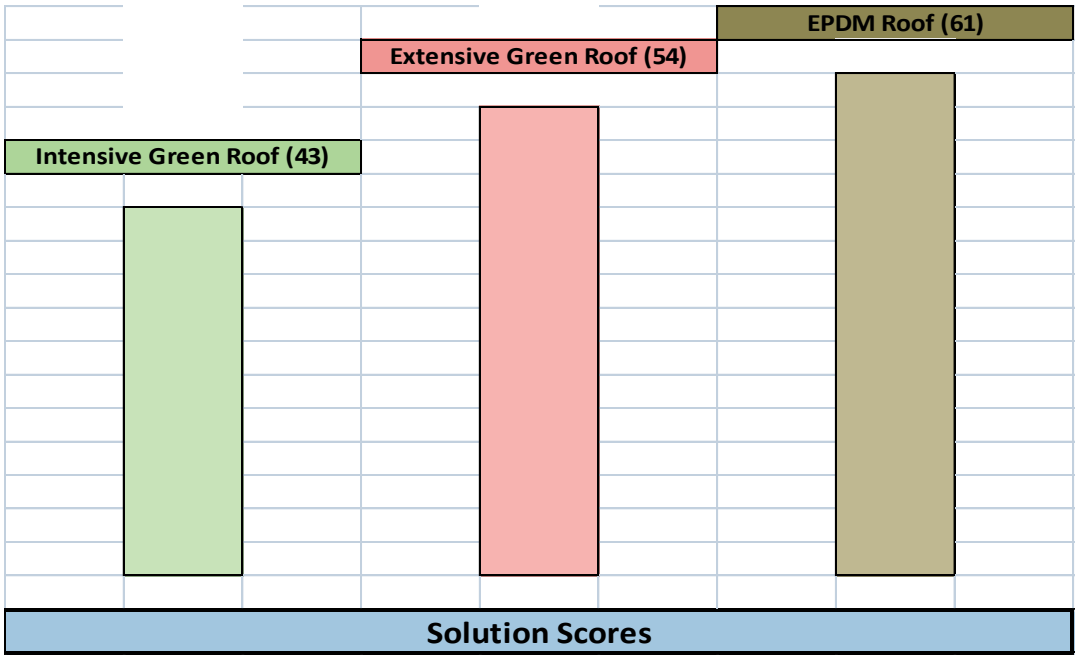
Shown in table 1.2 are the conclusions that the design matrix has realized. This matrix concludes that based on the given alternatives and criterion, the EPDM roof option displays the highest score. Besides modifying the alternatives, criterion, and or the weighting system this matrix states that the non-green roof would be the best choice for constructing the roof. To investigate further, histograms may be used to illustrate the differences in the solutions ratings and scores.

Table 1.3



This table illustrates the rating each criterion received from the matrix.

Table 1.4



This table illustrates the importance of the weighting system. Although the ratings of the criterion were similar, the scores differ due to the use of the weighted system.

CONCLUSIONS

An owner of a building can be overwhelmed by the amount of decisions that need to be made to move forward with the construction process. Executing a decision matrix can present the necessary information and help guide the decision makers to make a wise, objective decision.

IMPLICATIONS FOR PRACTICE AND ADVANCEMENT OF RESEARCH

This decision making matrix is now ready to be utilized in practice. The matrix itself can be easily modified to fit any design decision that one may have. Further advancement of the matrix includes broadening the range of types of decisions used to guide. It is also necessary to note that all elements should be carefully checked to ensure they are current.

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