SELECTION OF ENVIRONMENT FRIENDLY MATERIALS THROUGH VALUE MANAGEMENT: AN INTEGRATED PROCESS MODEL

R.M.A.S. Manewa[1], R. Rameezdeen[1], and R.D.G. Amaratunga[2]
[1]Department of Building Economics, University of Moratuwa, Sri Lanka
e-mail: anu_manewa@yahoo.com
[2]Research Institute for the Built and Human Environment, The University of Salford, UK
e-mail: r.d.g.amaratunga@salford.ac.uk

ABSTRACT: Value Management (VM) and Environmental Sustainability (ES) are increasingly becoming important tools to be considered in construction. At present the ES and VM have been practiced independently. This research is focused at producing an integrated process model by combining the two approaches to select construction materials. The proposed model is aimed at finding the best eco friendly materials, which gives value for money in construction projects. The material selection is based on the 'Combined Scoring Matrix', consisting of Green Labeling of materials and Multi Criteria Scoring. The model was verified through a case study for External Wall materials.

Key words - Eco-friendly Materials, Green Labeling of Materials, Scoring Matrix, Value Management

1. INTRODUCTION

The relationship between construction activities and the environment is well recognized (Ofori, 1997). On the global scale, the construction industry and its products consume a critical amount of material and energy sources, and are responsible for a very significant portion of pollution by harmful and damaging emissions and wastes (Hajek, 2001). Therefore, it is recognized that environment sustainability is to be considered in the life cycle of a construction project.

According to Gibbere (2003), Sustainability is the simple idea of ensuring a better quality of life for everyone now and for generations to come. Hayles (2003) further suggested that sustainability could be described in terms of social, economic and environmental states that are required in order for overall sustainability to be achieved. There are number of options to improve the environmental performance of buildings. According to Sturges (2004), application of environment friendly building materials is one of the best ways to improve environment performance.

With reference to Martin (1997), borrowing from the best of many different disciplines and management processes, Value Management (VM) is probably the most complete process available. McElligott and Norton (1995) have identified VM as a systematic, multidisciplinary effort directed toward analyzing the functions of projects for the purpose of achieving the best value at the lowest overall life cycle cost. Therefore, VM is one of the decision support tools that focuses on maximizing the functional value of a product and service. Martin (1997) further suggested VM started as a great concept, and has grown from both within it and from others. The process brings right people together at the right time regardless of where they are located in the supply chain, is an integrating function within the project value chain (Kelly, Male and Graham, 2004). Therefore, VM is always focused to achieve the sprit of every activity and attempt to eliminate unnecessary burdens. Therefore making link between VM and ES is crucial. Emmanual (2004) has identified the importance of achieving a trade-off between environment and economic costs in selection of building materials. Therefore the necessity is to introduce a system, which guides to select construction materials that have environmental and social soundness and at the same time fit with the economical agenda.

The overall aim of this research is to develop a model to fulfill a best value option through selecting eco-friendly materials. Several milestones have been achieved in the study including the thorough investigation of how sustainability is currently viewed and in particular how it impacts on the built environment. The research is further attempt to discuss the applicability of VM techniques in a delivery of sustainable construction strategies.

2. RESEARCH METHODOLOGY

A comprehensive literature survey on VM, and ES was carried out in the beginning of this research study. The Criteria Scoring Matrix and Material Green Labeling were selected as the best tools to maximize best value options and environment sustainability respectively. Few interviews were conducted to explore the views of experts in Environmental Economics and VM in local context. Finally a case study was carried out to test the model.

3. THE PROCESS MODEL

Most of the claims made about the economic benefits of sustainability are often marginal and difficult to quantify. Therefore, most of the clients hesitate to implement sustainable design principles, which will not give direct economic benefits. So the implementation of pure sustainable development methods may not be appreciated by most of the developers. This context changes when the consideration shifts from pure sustainability to value enhancement, because most of the developers expect the best value for their investment.

The proposed model is aimed to find the best eco friendly materials, which gives value for money in construction projects. The VM techniques and material green labeling technique are the core technical inputs of the process.

3.1 The Model Development Phase

The model consists of several stages. It begins from Pre-study phase. At this stage, client’s brief is thoroughly scrutinized. The orientation meeting is significant since it lay the proper base to carry on the entire process. The preliminary understanding of the project, client’s objectives, expected constraints and boundaries are critically evaluated at this meeting. Finalizing the correct composition of a team is crucial to the success of whole study. The Facilitator or Team coordinator leads the team, but the leader shall essentially a person who has handful of experience in both value management and sustainable construction. The ideas born through him supposed to eliminate environment hurdles, which will derive from the project.

The quality of the final results highly depends on the depth of information availability. Therefore, it is important to obtain every possible information especially cost related once and distribute them among the group members. The identification of poorly valued areas, available alternatives, and material significance of elements is important.

The Study Phase is the next stage of this model. At this stage further attention should be paid to obtain more reliable information of cost significant areas and to identify a comparative importance of each alternative. Functional analysis is an important technique, which is frequently utilized in VM. It helps to identify the poorly valued areas and value mismatches of project elements. The basic and secondary functions are scrutinized during this process. Functions, those are essential and satisfy the mandatory requirements of the project or an element is categorized as basic, and functions which are not essential and do not contribute to achieving a basic function is categorized under secondary functions. This analysis is focused on cost significant items only.

Calculation of Value Index is directed to persist the process further. The elements, which are having over ‘2’ of value index (Cost/Worth), are subjected to further evaluation (McElligott and Norton, 1995). When an element performs several functions the cost of that element or item may be prorated across the functions. The worth is considered to be the lowest cost at which only the basic functions can be achieved. The secondary functions are allocated a worth of zero. Having identified the poorly valued elements they are then broken down in to components as material, labour and plant. This process is known as fragmentation. Through fragmentation, the elements, which are having high material component, can be easily identified. In this case, if material component (X), is more than 1/3 of the total cost of that element it is included for further analysis.

The team leader is responsible to organize a brainstorming session and the team members are prompted to spontaneously produce ideas regarding the identified elements. The primary selection process is to ensure that only the credit enough ideas are carried forward through the process. This process is carried out on the basis of the main advantages and disadvantages of the alternatives generated. The significant impact will give in the analysis stage of the model. The proposed Integrated Process model for ES and VM is shown in Figure 1.

3.2 Analysis

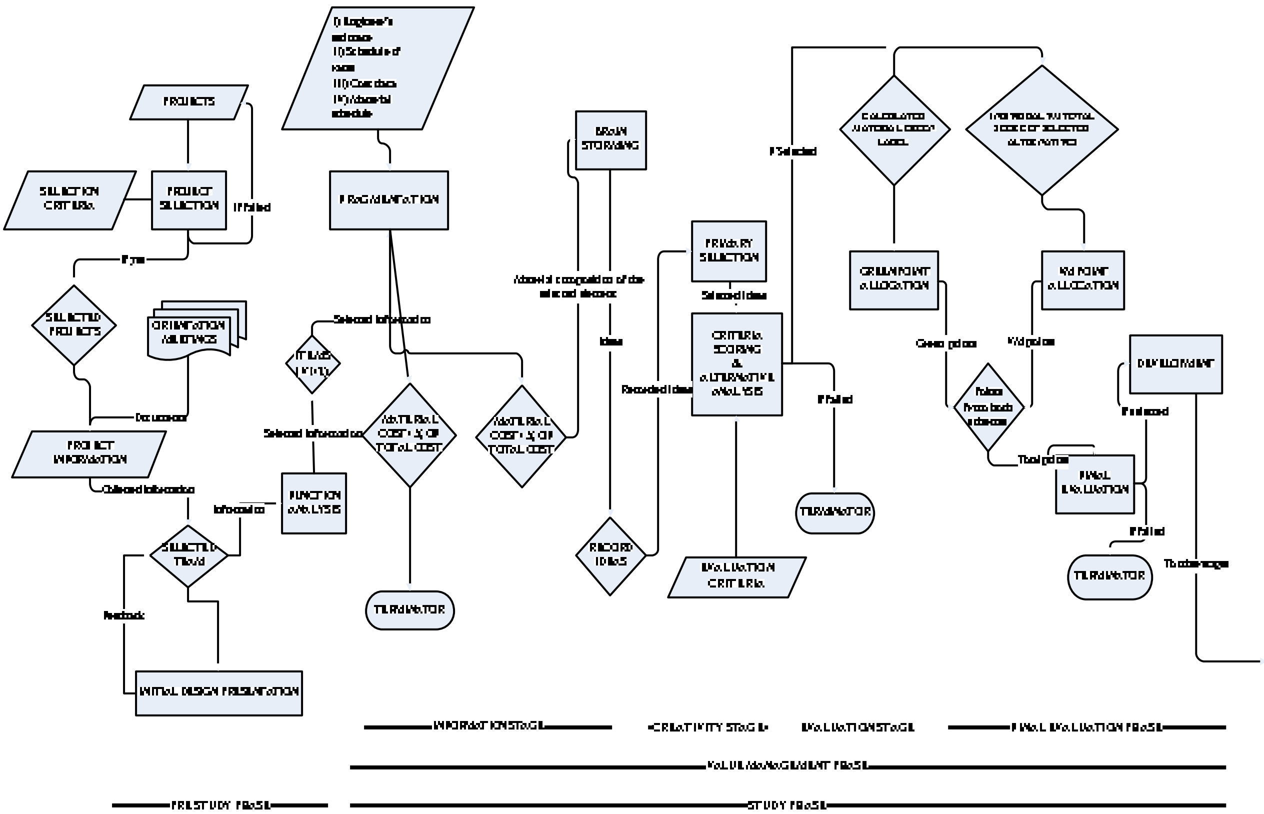
The crust of the model is based on the analysis of the VM proposals and ES of selected alternatives. The Combined Matrix, which is an amalgamation of criteria scoring and material green labeling processes. The significant criteria are listed out in the criteria-scoring matrix. While there is theoretically no limit on the number of criteria used and each criterion corresponds to a letter. It is important to establish criteria, where each criterion is entirely independent from others, because any overlaps will skew or bias the results (McElligott and Norton, 1995).

The next step is to assign a relative weight of importance to each and every criterion. This is an objective analysis and it commences with the comparison and rating of each criterion against all of the others. During comparison it is decided which of the two criteria is more important and the most important criterion is rated according to the key. When the comparison is over, the scores for each criterion must be totaled to provide a relative weighting for each of the criteria. This totaling provides the “raw score”. After completing the criteria scoring exercise, the next step would be the comparison of design alternatives on the “Alternative Analysis Matrix”. The multiplication of the criteria weight by the score for alternatives will reflect the degree of importance of each alternative. The unreasonable alternative scores would be analyzed further. Quite often the initial rating fails to reduce the number to be proceeded with, and then the team should run through the ideas highlighted to proceed to see which should be retained and which can be differed.

One of the tools to measure environment sustainability of materials is green labeling. It is embedded with most significant environment sustainable criteria. By considering these criteria the green points are allocated. Element is taken as the simple arithmetic sum of the each individual materials which builds up the element. But there are several environmental impacts to be considered, when the constituting materials are compiled together to form an element and these impacts are difficult to quantify. Therefore green star is focused on the direct impacts encountered through the individual materials.

Finally Points are allocated for the alternatives as per the score they have obtained both in VM scheme and ES scheme. The team can decide the final selection of alternatives. The alternatives that have scored fairly high can be selected to proceed with development phase.

The objective of this phase is to develop the selected ideas as practicable proposals. The selected ideas present as proposals to the decision makers in Presentation phase. Generally those proposals will embedded with description of the original and proposed material composition of the element, advantages and disadvantages of each, life cycle cost implications and supportive technical back – ups.



cost significant materials. This contraction of scope will increase the efficiency of the study, because it will reduce the amount of items to be considered within the process. Most probably the majority of environmental friendly materials would not be the most economical alternative for an element. The inclusion of such an alternative in the design will result to have cost overruns in client's budget. If so the developer may not enjoy the real value of the investment. But the model has given flexibility to use any of the VM techniques available to reach the required results. This technical flexibility can be seen in many in the stages down the line in the process. The collaborative or grouped behaviour has not been considered when deriving the green labels for the materials. However, in construction most of the materials are compiled together to form required elements or items of the built environment.

5. A CASE STUDY

A case study was carried out to select the environment friendly material for external walls through VM. Four types of external wall materials are studied and 1 m^2 of wall area was chosen as the functional unit. The green labeling scores in Table 1 is based on the results obtained from Life Cycle Assessment (LCA) by Rameezdeen etal (2002) and Sivapalan (2002). The weights are determined in accordance with the importance of selected criteria for the decision maker.

The reusability, renewability and recyclability of raw materials, total energy consumption of them and average wastes and pollution effects to the environment were selected as the most significant criteria which causes direct effect to environment. The comparative percentage scale was used to measure the raw material reusability, renewability and recyclability. The quantification of remaining impacts were based on the previous research findings. The green score is the amalgamating of above set of criteria. Then relative weighting (Point 1) is assigned in a range between one and ten. Thus the highest raw score will be assigned a weighting of one and the lowest (including zero) ten. Others will be assigned prorated weightings between one and ten.

Under the umbrella of value maximization of external wall materials, the Initial cost, maintenance cost, aesthetic quality, insulation properties, time requirement for construction, durability, acoustic properties and weather resistance were considered. For the criterion of aesthetic, the measuring unit was a subjective scale. Other criteria were measured through their standard units of measurements. Using criteria scoring matrix the total VM score was calculated. The relative weighting (Point II) for VM scores is assigned in a range between one and ten. But the highest raw score belongs to a weighting of ten and the lowest is (including zero) one. Others will be assigned prorated weightings between one and ten.

The total scores belonging to a particular alternative was calculated and given as a percentage of total scores that an alternative can achieve. The findings of the case study can be summarized in Table1.

Table 1: Results obtained through Combined Scoring Matrix

Selected alternatives	**Green scores**	**Points (I)**	**VM scores**	**Points (II)**	**Total (%)**
R/F concrete	127	1	98	10	55
Brick walls in 1:6 C: S mortar	71	10	95	8	91
Solid block walls in 1:6 C: S mortar	84	7	88	7	70
Hollow block walls 1:6 C: S mortar	84	7	74	1	40

6. RESULTS AND DISCUSSION

The calculation of value and environment sustainable performance was carried out using criteria scoring and green labeling respectively. Alternative analysis shows that the reinforced concrete walls are the most suitable alternative when considering the economical and functional viability using VM.

The brick walls found to be the best choice from the environmental point of view since it obtained lowest green score value. Additionally the result shows the small gap between green score of brick walls and other alternatives.

7. CONCLUSION

The VM is one of the decision techniques, which is commonly used in construction industry to achieve best value options. The proposed integrated process model has been developed and applied on a case study in which a decision should be made on four types of external wall materials. The case study showed that the process can be successfully implemented and it is possible to have the middle path, which will stand as value added sustainable selection.

It is found brick as the best material, which fulfills both options effectively. The process is aimed at the VM techniques, which will be adding value to the selected environmentally sound material. Tools that help the selection of sustainable construction ingredients can advance the cause of sustainable development. Further the environment sustainability and economical viability of a project is primarily connected with the material selection. Therefore it is important to formulate a decision support tool, which facilitates the comparison between environmental and other desired aspects. Therefore a new way of thinking must be adopted to redirect the development towards sustainability in each activity of construction.

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