Application of Decision Making Tool in Sustainable Construction

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Abstract - *The construction industry has a greater impact in the worldwide energy scenario by contributing in pollution, high energy consumption, amongst others. Therefore, a sustainable construction is a need to lower these impacts and to achieve social and economic benefits. In a project, decisions are made either quantitatively or qualitatively to improve the potential for success in terms of cost and time measures for a prescribed level of quality. Proactive sustainability considerations are often secondary concerns on individual projects. Decision analysis is often used to help decision makers choose among alternatives, based on the expected utility associated to each alternative as function of its consequences and potential impacts. Value management (VM) is proposed as a tool used to promote sustainable building (SB). VM aims to achieve optimum value of a project based on its objectives and its approach is much similar with sustainability which ideally focusing on achieving values, not just economically, but environmentally and social aspects of the project. A decision making tool aims by defining the importance of sustainable construction and implementing normalization of procedures.*

Key Words: Sustainable Construction, Decision Analysis, Decision Making Tool, Value Management, Sustainable Goals

1. INTRODUCTION

A "green building" (GB) or a "sustainable building" is a high performance building that is designed and constructed in a resource-efficient manner to preserve energy, water, materials, and land throughout its life cycle while providing healthy environments for its occupants through the application of "environmental" principles. GB projects require multiple technical disciplines to have elevated levels of interdependency and interconnectedness. To this effect, there is increasing need for environmental awareness in the industry, making the term 'sustainable construction' (SC) to become popular and inevitable. To explore options for development of a construction-specific decision support tool for sustainability, the constraints within the industry and alternative approaches for implementation can be find out.

1.1. Sustainable Constructions

Sustainability means the use of natural resources in such a condition of equilibrium that they do not reach decay, depletion and an non-renewable point and can be handed down to the next generations. It is defined as the creation and responsible management of a healthy built environment based on resource efficient and ecological principles. The aim of SC is to reduce or eliminate environmental problems and issues associated with built facilities and construction activities while maximizing the potential benefits to society and the economy. However, there are several challenges to the adoption and implementation of SC in the construction industry. Identifying these barriers is imperative to successfully proffer a methodology with more sustainable potential for the industry.

Sustainable principles

- Resource (material and energy) efficient using-: Low energy processes
- Evolve to survive-: Repeat successful approaches
- Adapt to changing conditions-: Maintaining integrity through self-renewal
- Integrate development with growth-: Building from the bottom up, Self-organizing
- Been locally attuned and responsive-: Readily available materials
- Using life-friendly chemistry- Use water as solvent

1.2. Decision Making (DM)

Many project teams (large firms or small firm) processes which embody detailed requirements and specifications that lead to additional tasks for the project team (i.e., detailed documentation and advanced green system design and implementation) that elevate the level of complexity for the whole project delivery process. This relatively novel concept results in some unique challenges for project teams and decrease productivity throughout design and construction phases of GB project delivery. Decision support systems are often used to guide decision makers (project team) towards the best decision. Following a structured methodology, it aims at selecting one out of different available alternatives, based on the consequences associated to each alternative.

With the need of sustainable construction, cost optimization has become comparatively important in today's date. Consideration of these important factors i.e. sustainability and cost optimization functional utility has got emphasize in last few years whose object is to effect economy, in the cost of construction of project. Value Engineering is an organized, creative and cost search technique for analyzing the function of any product, service, or system with the purpose of achieving the required functions at the lowest overall cost consistent with all the requirements that comprise its value, such as performance, quality, reliability and appearance. This may prevent achievement of project objectives related to time, cost and sustainability.

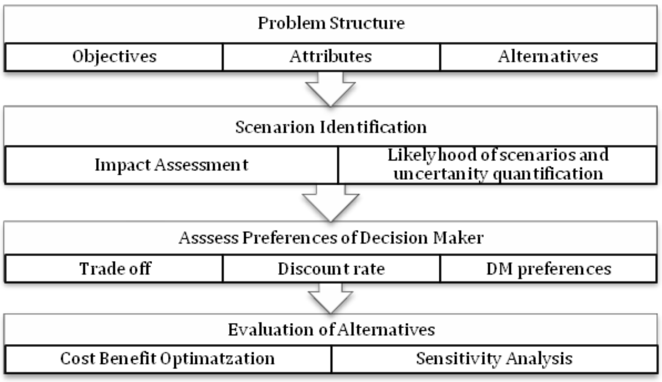

Figure No. 1 Steps of the Decision Making Process

2. THE CONSTRUCTION PROCESS AND CONSTRUCTION DECISION SUPPORT

Sustainable development is a multi-dimensional and multi-disciplinary concept. Various sustainable based concepts have been applied in order to achieve sustainability. Despite its growing popularity in world, the implementation of SB has to defy various barriers and challenges. There are generally nine (9) form of barriers to SB which includes a) steering b) costs, risks and value, c) demand, d) tendering and procurement, e) process phases and tasks, f) cooperation and networking, g) knowledge and common terminology, h) availability of integrated methods and i) innovation process. To overcome these challenges, various construction parties needs to be involved and specific decision support tool/decision analysis needs to be done-

A. **Pre-construction Process**:

i. Developing Estimate and Bidding-Assumptions are made as to techniques employed, crews utilized, equipment spreads, and productivity rates. Each of these assumptions influences the cost and the schedule. If sustainable equipment is costlier or less productive, it is unlikely that the bid price will be developed using sustainable equipment assumptions.

ii. Planning and Scheduling-The project management team will base decisions in planning and scheduling upon the assumptions made in the construction estimate. Techniques assumed may be challenged and changed. Where alternative approaches are taken, however, the project management team must be cognizant of the effect on the project costs and time to ensure overall project success.

B. **Management Practices**-Contractors shall finalize financing, insurances, bonding and other contractual duties as per contract. Equipment and labor must be assembled and commitment obtained for their allocation to the project. Best management practices with respect to productivity and construction safety should also be employed as such activities have positive benefit on the cost and schedule in addition to the sustainability.

C. **Project Close-Out:** When the estimate is developed, accepted and contract terms finalized, the cost of the project is solidified. Where costs or time deviations occur in project delivery, additional costs are typically incurred; therefore, the goal of project delivery is to maintain and control the schedule in order to ensure overall cost, time and quality success. Sustainable elements, such as energy efficient offices and recycling facilities, may have already been implemented if cost advantageous or required as per contract. During project completion, startup and turn-over, details are finalized and delivered.

1. Specifying performance and actions that must be taken by the contract (i.e. regulating specific actions)

2. Developing a rating-based approach similar to the philosophies employed by GRIHA, LEED & BEE for implementation and evaluation of the construction process. The owner would then require contractors to demonstrate achievement of a specific rating/level of performance (i.e. credit ratings/star ratings.)

3. Require implementation of a sustainability-based management process, similar to value engineering or require specific management activities, such as sustainability-oriented optimization of resources. These could be required as part of the project planning and approval process.

4. Risk-based decision making is a widely used tool to assess performance and evaluate policies for complex systems and services where potential risks

exist. ISO2394:2015 is the reference standard for both reliability and risk based decision making concerning design and assessment of structural systems. The standard frameworks, provides a more detailed description of the assessment procedure. The evaluation of risk analysis results, with respect to acceptance risk criteria. Risk assessment can be conducted in a qualitative way, semi-quantitative or quantitative way. Uncertainty is widely analyzed in quantitative risk-based decision analysis but less or not at all analyzed in qualitative and semi-quantitative risk assessment.

5. Cost-benefit analysis (CBA) assumes that for each alternative, a specific consequence can be assigned in terms of cost and different benefits. The best alternative will be the one whose cost does not exceed the available budget and whose benefits fulfill minimum “aspiration levels”. The alternatives are then ranked according to e.g. benefit-cost ratio and net present value. Additional limitations arise since both costs and benefits are often monetarized in CBA by deterministic values, where uncertainties of those values are not always available. Discounting of costs and benefits over time is always applied in CBA, to actualize the future monetarized value of costs and benefits.

6. Life Cycle Assessment (LCA) is applied in various cases to: 1) identify the environmental hotspots in the building or/and 2) compare the environmental impacts of different alternatives that can be applied in the building to achieve the same function. The construction building is analyzed over the whole life cycle of “service”. A data collection for all life stages of the service, i.e. raw material, manufacturing, use and end-of-life stages analysis is done to draw life cycle impact. Using relevant weight indicators, a cause-effect chain that describes the relationship between the flow and the damages on process/products/materials of protection (natural environment, human health and resources) is drawn.

Uncertainty, which refers to the incompleteness of knowledge or the lack of understanding, affects largely the decision process. Epistemic uncertainty is caused by lack of knowledge and can be reduced e.g. by means of further measurement or study of the quantity, processing or system. Following Figure No. 2 shows types of uncertainty sources.

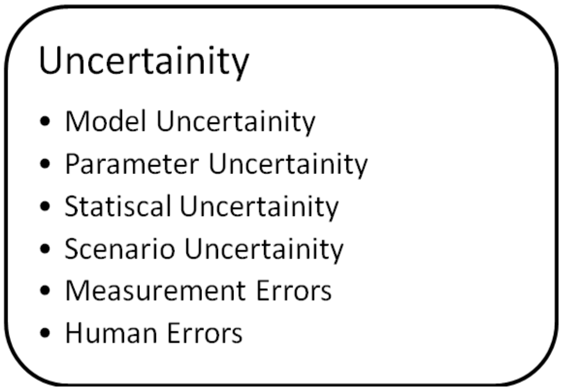

Figure No. 2 Types of Uncertainty Sources

2.2. Value Management

Value Management/Value Engineering is a Decision-Making Methodology. The greatest gains of Value Management have been shown when it is directed towards obtaining maximum value from a total system. Value Management studies should be scheduled at optimal points in the project lifecycle and structured to meet the objectives relevant to the particular stage of the project. The specialized knowledge required in value improvement work consists of information on materials, processes, functional products, sources of functional knowledge, approaches to function performance, and practical ideas for economical function performance. It is important that the value engineer’s library of special knowledge contains a comprehensive volume of trade knowledge backed by efficient means for a quick recall of needed information. Value engineer also needs well-organized references to a maximum number of persons of special skills that may be consulted in connection with each problem. Value engineers need develop a database having the association between properties of materials and costs apart from material and its cost.

Value as used in Value Management / Value Engineering can be defined as: The lowest cost to reliably provide the required functions or service at the desired time and place and with the essential quality.”

VALUE = FUNCTION / COST

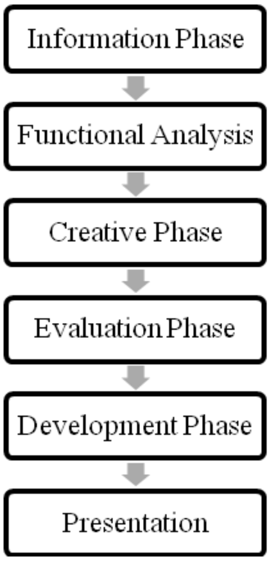

Figure No. 3 Value Management Process

2.3. Value Management Process

1. INFORMATION
   Identification and testing of project rationale from the perspective of stakeholders' positions e.g. alignment with Corporate Objectives and/or Service Strategies.
2. FUNCTION ANALYSIS
   Identification and ranking of primary and secondary functions and their associated cost and worth relationship.
3. IDEAS GENERATION
   Generation of value improvement options through innovation and alternate means of achieving the required function.
4. EVALUATION
   Sorting and prioritizing value improvement options to identify viable alternatives. Evaluation of Options may continue beyond the Value Management Study.
5. ACTION PLAN
   Identification of actions/strategy required to achieve Value Study outcomes and to provide ongoing management framework for project progression.
6. ANALYSIS AND REPORTING
   Final reporting includes a description of outcomes and documentation of rationale to ensure appropriate focus is maintained through the project development stages.

2.4. Implementing sustainability workshops

Implementation of a sustainability-focused management process is similar to value engineering, as part of the project planning and approval process. This can be implemented through a workshop focused approach during the pre-construction period in conjunction with the planning effort. Specific elements, such as resource optimization for emissions minimization, could be prerequisites to this process. The sustainable workshop requires structures and should follow a value engineering methodology as shown in Figure No. 3.

This workshop would allow training labor in pre-construction period, accepting new equipments to understand and analyze by the project team.

CONCLUSIONS

- To increase the effectiveness of implementing projects in a sustainable manner, various approaches for construction sustainability were determined and discussed. To achieve sustainable goals, sustainable principles were listed.

- It is clear that economic benefit and cost, and impacts on human health are major concerns in decision analysis theory. Decision support tools like certification rating tool, LCA, CBA and RBA assess a full set of impact to analyze the profile of the compared alternative as well as it ventures possible problems and outcomes that the project will have to face.

- Value engineering/value analysis creates cost and quality consciousness among the employees. Quality is maintained at desired level because there is no question to reduce cost at the expense of quality. The functionality of the project is often improved as well as producing tremendous savings, both initial and Life-Cycle Cost.

- The potential of Value Management in delivering sustainable project and in contributing to the increasing sustainability value of a project should be introduced to the industry. The greatest impact will be realized when the practitioners are given the opportunity to include sustainability issues into VM processes at the early stage of the project. When VM is frequently adopted, sustainability construction projects will become more develop and therefore the VM-SB integration is nascent

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