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Resilience of the Integrated Building: A Community Focus

Value Engineering Evaluation Method for Sustainable Construction

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OVERVIEW

- Introduction
- Literature review
- Research Method
  - Aim, objectives and hypothesis of the study
  - Case study
- Results
  - Descriptive statistics
  - Inferential Statistics
- Discussion
- Conclusion

INTRODUCTION

Green Construction
Eco-friendly
Resource efficiency
High Performance Buildings
Healthy buildings
Net-zero buildings
Triple bottom-line

Sustainable Development
Sustainable Construction

- Goal is to meet the needs of the present population without endangering the ability of the future generation to meet their own needs (Kibert 2016; Hajek 2002)

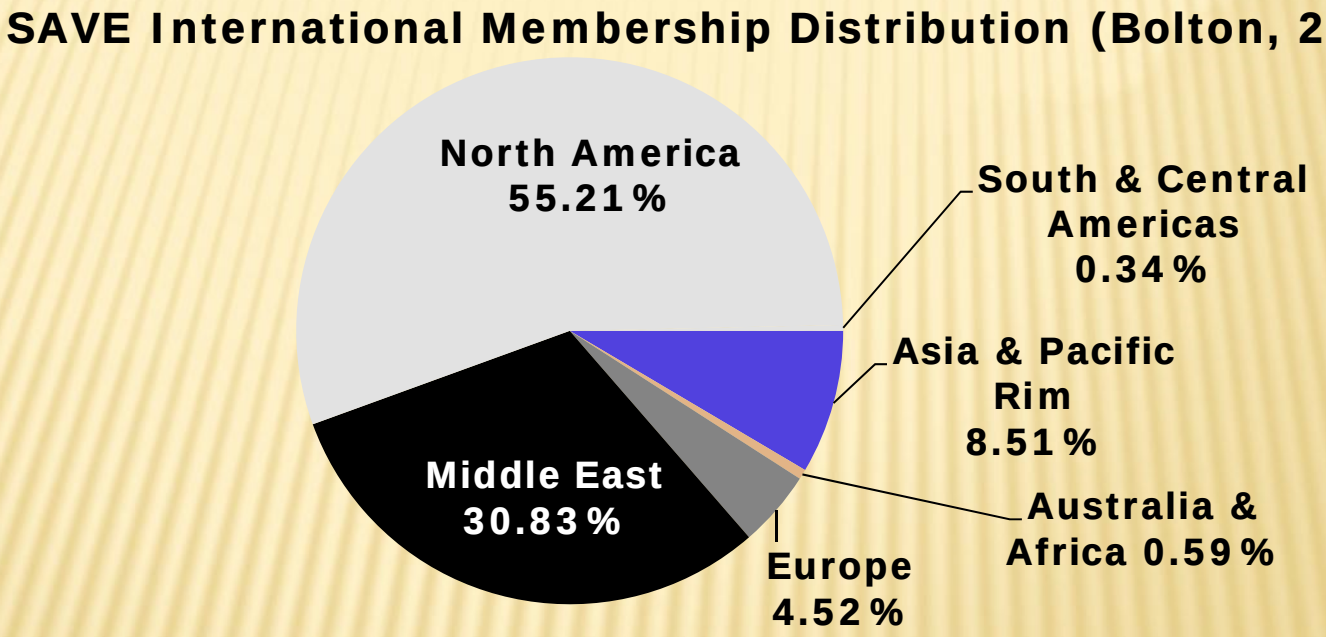
- Employ assessment tools, e.g., Envision, LEED, Green Globes, BREEAM (UK), CASBEE (Japan), DGNB (Germany), etc
  - Each has unique assessment criteria

INTRODUCTION

- Meeting sustainability needs can be challenging and may require robust decision tools (e.g., MCDM);
  - GP, Utility Theory, Weighted Analysis Method (WAM), Analytical Hierarchy Process (AHP)
  - MCDM has limitations especially in meeting sustainability goals
- Value engineering (VE) is a potential tool that can be used to provide **value** in sustainable construction
  - A systematic, ***function-oriented*** and multidisciplinary team approach that aims at *reducing cost* while maintaining or improving *performance and quality* of systems or project
  - Started at GE by L. Miles (World War II)

INTRODUCTION

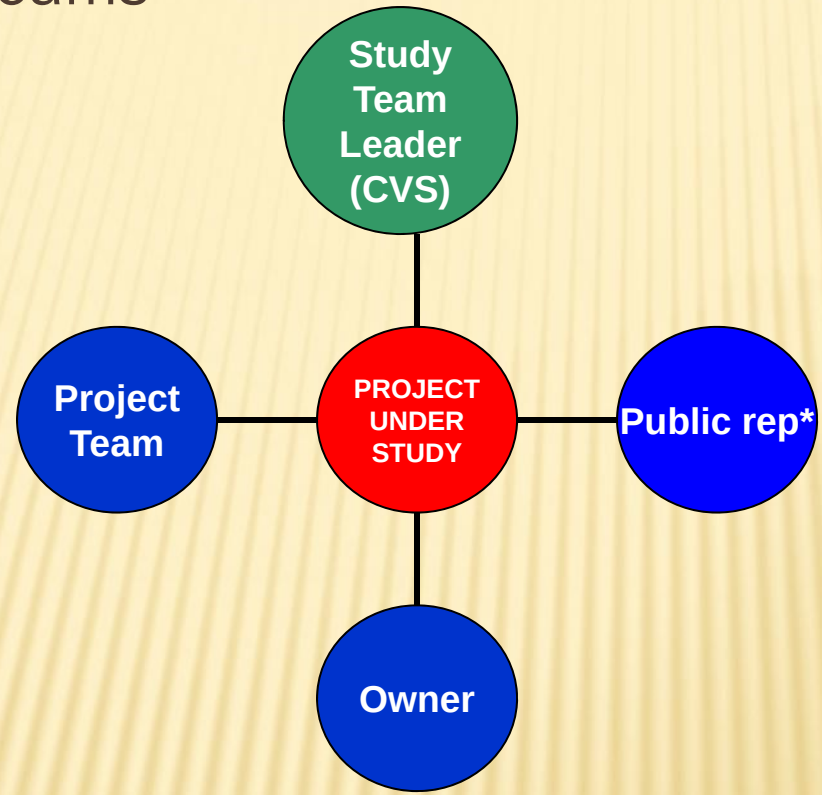
- VE is promoted by;
  - SAVE International



  - ASTM E1699-14: Standard practice for performing VE/VA of projects, processes and products

INTRODUCTION

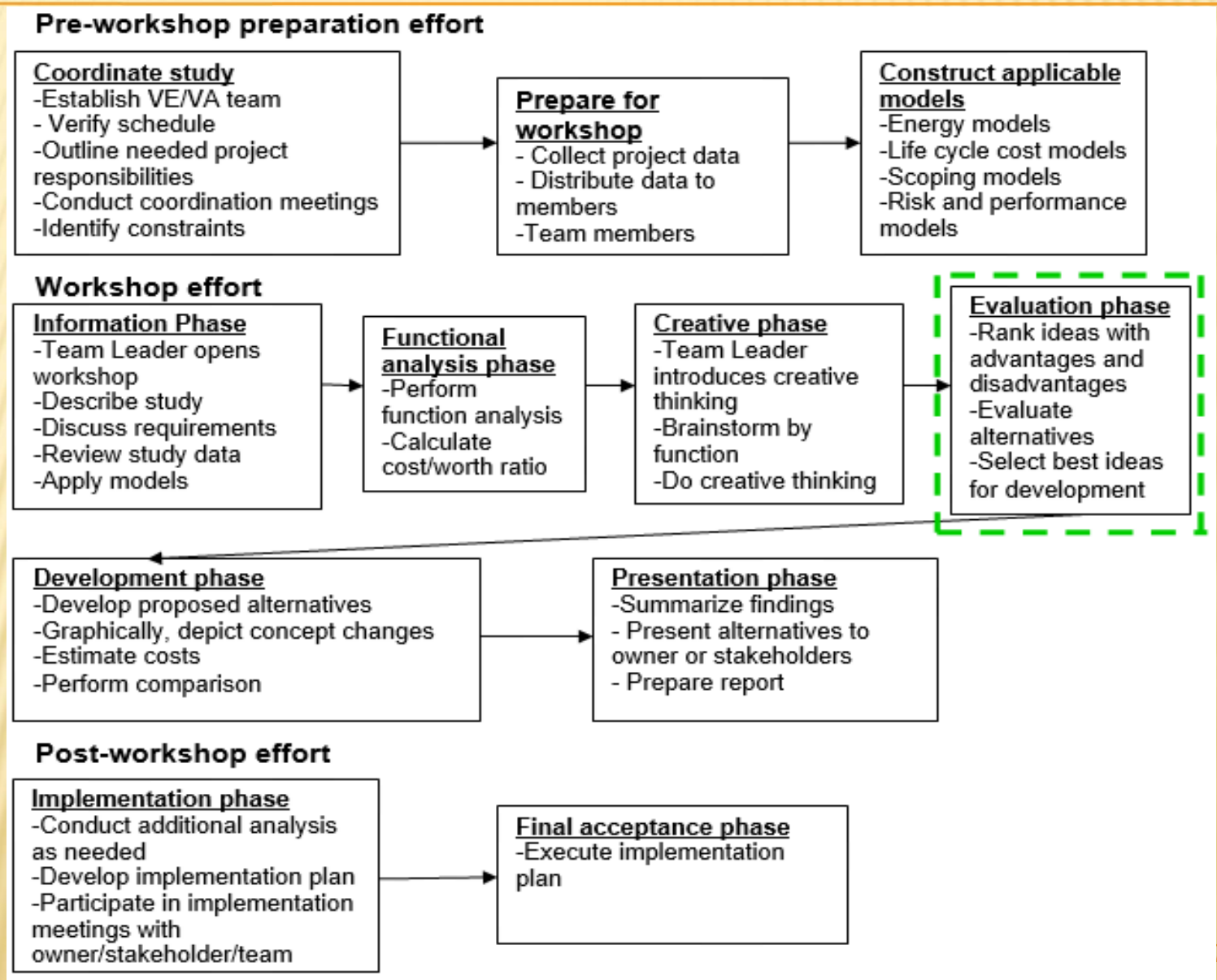
- VE involve teams



- Need cohesive team with good communication (better understanding of FUNCTIONS) and creativity in developing alternatives

INTRODUCTION

- Job plan (ASTM)



LITERATURE REVIEW

- Project owners may be hesitant to include sustainability goals
  - Increased first cost (Morris, 2007) Vs LCC/LCA (Kibert, 2016)
  - Including sustainability principles depend on the commitment of the owner and knowledge of the VE team (Wilson, 2005).

- VE applications can result in 5-35% cost savings with ROI of about 200-222% (Chung et al., 2009; Wilson, 2005)
  - VE need early integration in projects to reap full benefits

LITERATURE REVIEW

- Focus is mostly to reduce costs (quantitative) and not much on performance and quality improvement (qualitative).
  - Project owners focus more on how much $$$$$ to **cut**
  - ASTM (2014) and SAVE International standard (2015) focus more on cost reduction aspect
- EVALUATION of systems to select the best ALTERNATIVE for implementation in project(s) is key to the success of VE
- Limitations of WAM used in evaluating alternatives developed
  - Using pair-wise comparisons to determine relative importance of each alternative
  - Abstract allocation of weights to criteria
  - Using both advantages and disadvantages to rank alternatives

ALTERNATIVELY (AND CONSIDERING SUSTAINABILITY)

- Using CBA to alleviate the limitations of conventional VE
  - Decisions must be made based on relevant facts
  - Advantages are to be used in the evaluation process
    - **Importance of advantages** of alternatives
  - Does not recognize WRC principle, and all other principles of MCDM (e.g., allocation of weights to criteria, pairwise comparisons and use of both advantages and disadvantages in evaluating alternatives)
  - Considers both quantitative and qualitative factors

RESEARCH AIM, OBJECTIVES AND HYPOTHESIS

- The purpose of this research was to refocus the conventional VE process to improve sustainable construction outcomes
  - Objectives were to identify the limitations in the evaluation VE phase and find redress, and assess the impact of the new VE methodology to sustainability outcomes
  - The hypothesis was that the new VE method would provide better building sustainability outcomes
  - Case study building was used to test the VE methods
  - SAS v9.4 was the basis of the quantitative statistical analysis
    - Descriptive statistics and ANOVA(F-test)

RESEARCH METHODS: CASE STUDY

- The research utilized a sustainable building
  - Was in construction stage
  - Aiming at LEED platinum plus certification
- VE course graduate students prepared VE reports
  - Assigned to experimental groups
  - Team 1 not trained (and used conventional VE); team 2 trained (used new VE method)

Table 1: Summary of research experimental design involving VE students (N= 13)	
Method 1	Method 2
Team 1A	Team 2A
Team 1B	Team 2B
Total = 6 students	Total =7 students

RESEARCH METHODS: CASE STUDY

- Method 1 (Control/conventional VE method):
  - Employed the conventional VE method that entailed developing quality model, pair-wise comparisons of criteria, and weighting, rating, and calculating (WRC) method.
- Method 2 [CBA method in Evaluation Phase]:
  - Employed the CBA method in evaluating the alternatives.

RESEARCH METHODS: CASE STUDY

- Faculty members inclusion
  - VE reports were evaluated by faculty with expertise in sustainable construction-LEED (N=4)
    - Ability of systems to meet the LEED criteria (EA, M&R, IEQ)
    - Rating criteria was:

      somewhat fair contribution = 1, fair contribution = 2, good contribution = 3, very good contribution = 4 and excellent contribution = 5

Note: These evaluations provided the data to assess the effectiveness of the two VE methods in providing better building sustainability outcomes

RESULTS

Table 2. Summary of the ratings of the contribution of systems to sustainability

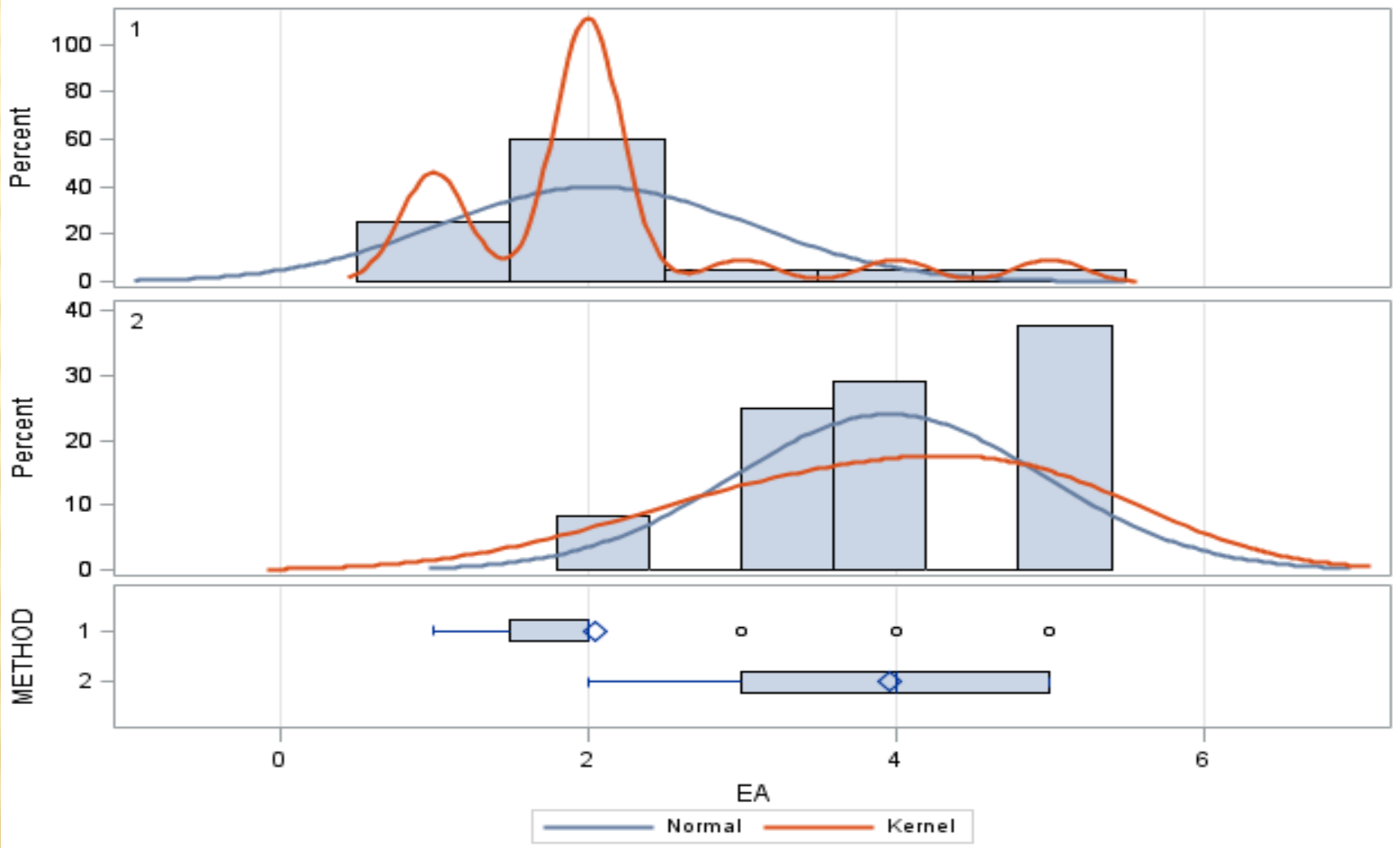
	Method 1			Method 2		
Category	N	Mean	Std	N	Mean	Std
Energy and Atmosphere(EA)	20	2.05	1.00	24	**3.96**	1.00
Materials and Resources (M&R)	18	2.17	0.86	23	2.65	1.19
Indoor Environmental Quality (IEQ)	16	2.19	0.75	22	2.50	1.19

Descriptive Statistics

Implication (initial): VE method 2 could be better than method 1

RESULTS

Figure 2. Distribution of Energy and Atmosphere LEED Credit Rating



Implication (initial): VE method 2 could be better than method 1

RESULTS

Table 3. Summary of ANOVA results

Source	Df	Error	Corrected Total	Sum of Squares Error	Mean Square Error	F-value	Sig.
EA	1	42	43	41.91	1.00	39.81	**< .0001**
M&R	1	39	40	34.72	2.38	2.12	0.153
IEQ	1	36	37	37.94	1.05	0.86	0.360

ANOVA Statistics

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Statistical significance, [F (1,42) =39.81, p < .0001)] at p = .05

Implication: VE method 2 could be better than method 1

DISCUSSION

- CBA assists in selecting systems based on the importance of advantages; and that decisions must be based on relevant facts and not abstractions or other principles of MCDM.

Sound Decisions → Better Actions → Better Results/Outcomes

- Statistically significant result imply that VE method 2 (CBA) could be better than conventional VE method 1 (sustainability speaking).
  - Thus, the research hypothesis is supported

- The VE team can therefore focus on **both** the cost reduction, and performance and quality improvements.
  - Owners can receive value when the approach is executed well

CONCLUSION

- Based on the analysis, the CBA method could be a worthwhile inclusion in the new VE methodology to improve sustainable building construction outcomes
  - In the Evaluation Phase of the VE phase

REMEMBER:

STATISTICS MEANS *NEVER HAVING TO SAY YOU ARE CERTAIN*....but you can confidently imagine.

ANY COMMENTS, THOUGHTS OR IDEAS??

THANK YOU!

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