AHP AND CBA APPLICATION TO LAYOUT DESIGN: A CASE OF CLASSROOM LAYOUT ASSESSMENT

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INTRODUCTION

- Diverse and multidisciplinary stakeholders with conflicting objectives

- Lean literature – TFV, TVD, CBA, etc.

Stakeholder Values - The Case of University Campus Bldgs. (Sahadevan and Varghese 2018)
**AHP v/s CBA**

### AHP steps
- Develop analytical hierarchy
- Obtain pairwise comparison from experts
- Create pairwise comparison matrix
- Normalize pairwise comparison matrix
- Arrive at a priority vector
- Repeat the process for obtaining scores
- Check consistency
- Analyze to obtain priority ranking

### CBA steps
- Identify alternatives
- Define factors
- Define must have/want criteria for each factor
- Describe the attributes of each alternative
- Decide the advantages of each alternative
- Decide the importance of each advantage
- Evaluate cost-design
Criteria for Layout Evaluation

Goal

Classroom layout ranking

Criteria

Functional  Image  Sustainable  Social  Flexible  Design quality  Health

Alternatives

Traditional  Tiered  Interactive
RESEARCH METHOD
# RESEARCH METHOD

<table>
<thead>
<tr>
<th>Category</th>
<th>Layout 1</th>
<th>Layout 2</th>
<th>Layout 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of classroom</td>
<td>Traditional</td>
<td>Tiered</td>
<td>Interactive</td>
</tr>
<tr>
<td>Capacity (seater)</td>
<td>42</td>
<td>45</td>
<td>45</td>
</tr>
<tr>
<td>Area (sq.m.)</td>
<td>119</td>
<td>110</td>
<td>141</td>
</tr>
<tr>
<td>Cost (₹)</td>
<td>6,95,000</td>
<td>12,57,000</td>
<td>8,00,000</td>
</tr>
<tr>
<td>Embodied Energy (GJ)</td>
<td>1401</td>
<td>2995</td>
<td>1123</td>
</tr>
<tr>
<td>Reverberation time (s)</td>
<td>0.34</td>
<td>0.28</td>
<td>0.5</td>
</tr>
</tbody>
</table>
Selection of participants

Elicitation of ad-hoc judgement

Familiarizing with CBA & AHP vocabulary

Elicitation of criteria for decision making

AHP & CBA sessions
## RESULTS - AHP

### Individual Judgement

<table>
<thead>
<tr>
<th>Faculty</th>
<th>Rank 1</th>
<th>Rank 2</th>
<th>Rank 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Faculty 1</td>
<td>Tiered</td>
<td>Interactive</td>
<td>Traditional</td>
</tr>
<tr>
<td>Faculty 2</td>
<td>Tiered</td>
<td>Traditional</td>
<td>Interactive</td>
</tr>
<tr>
<td>Faculty 3</td>
<td>Interactive</td>
<td>Traditional</td>
<td>Tiered</td>
</tr>
<tr>
<td>Faculty 4</td>
<td>Tiered</td>
<td>Traditional</td>
<td>Interactive</td>
</tr>
</tbody>
</table>

### AHP scores

<table>
<thead>
<tr>
<th>Faculty</th>
<th>Traditional</th>
<th>Tiered</th>
<th>Interactive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Faculty 1</td>
<td>0.280</td>
<td>0.332</td>
<td>0.388</td>
</tr>
<tr>
<td>Faculty 2</td>
<td>0.275</td>
<td>0.315</td>
<td>0.41</td>
</tr>
<tr>
<td>Faculty 3</td>
<td>0.07</td>
<td>0.707</td>
<td>0.223</td>
</tr>
<tr>
<td>Faculty 4</td>
<td>0.742</td>
<td>0.183</td>
<td>0.075</td>
</tr>
</tbody>
</table>
RESULTS - CBA

Percentage of participants

<table>
<thead>
<tr>
<th>Layout types</th>
<th>Rank 1</th>
<th>Rank 2</th>
<th>Rank 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tiered</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interactive</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Ad-hoc judgement
# RESULTS - CBA

<table>
<thead>
<tr>
<th>Factors</th>
<th>Alt.1: Traditional</th>
<th>Alt.2: Tiered</th>
<th>Alt.3: Interactive</th>
</tr>
</thead>
</table>
| **1. Functional**  
1a. Provision of all classroom requirements  
**Crit.: Higher is better** | Att: Provided | Att: Provided | Att: Provided |
| **1b. Acoustics**  
**Crit.: Reverberation time (s) within permissible limits** | Att: 0.34 (within permissible limits) | Att: 0.28 (within permissible limits) | Att: 0.5 (within permissible limits) |
| **1c. Planning of spaces & circulation**  
**Crit.: Better ability to walk around the classroom** | Att: Some circulation space | Att: Less circulation space | Att: More circulation space |
| | Adv.: Some ease for users to move around in the classroom | IofA:20 | Adv.: | IofA: | Adv.: | More ease for users to move around in the classroom | IofA:100 |
| **1d. Electrical layout**  
**Crit.: Better accessibility of charging points** | Att: Adequate accessibility | Att: Adequate accessibility | Att: Adequate accessibility |
| **2. Image**  
**Crit.: More appealing is better** | Att: Some orderly arrangement | Att: Orderly | Att: Least appealing/ could get disorderly |
| | Adv.: Less visual appeal | IofA:30 | Adv.: Visually appealing | IofA:90 | Adv.: | IofA: |
| **3. Sustainable**  
**Crit.: Embodied Energy (GJ), lower is better** | Att: 1401 | Att: 2995 | Att: 1123 |
| **4. Design quality**  
**Crit.: More the area (sq. m.) was considered better for the user** | Att: 119 | Att: 110 | Att: 141 |
| **5. Social**  
**Crit.: Higher interaction opportunities are better** | Att: Low interaction opportunities | Att: Moderate interaction opportunities | Att: High interaction opportunities |
| **6. Flexible**  
**Crit.: Ease of future adaptability to changes, higher is better** | Att: Can be modified with some ease | Att: Cannot be modified easily | Att: Can be modified with greater ease |
RESULTS - CBA

Cost $v/s$ IofAs

- Tiered
- Traditional
- Interactive
DISCUSSION

- Role of individual preferences in decision making
- Soundness of decision making
  - Consistency
  - Context-specific
  - Transparency of trade-offs within and among factors
  - Subjectivity
  - Collaboration and transparency
  - Abstractness of criteria
- Ease of operationalizing of the techniques
CONCLUSIONS

● AHP
  ● Capturing individual preferences
  ● Subjective and abstract criteria
  ● Provides structure
  ● Issues with consistency and trade-offs

● CBA
  ● Informed collaborative decision
  ● Transparency
  ● Sound criteria and sub-criteria
Questions???