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RESEARCH ARTICLE

The Architectural Features of Peruvudaiyar Kovil (BRIHADEESWARAR TEMPLE)

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Abstract

A Candor temple in the Chola period, stand for both cultural heritages, religious and in the field of architecture, is Brihadeeswarar Temple. This study aims to systematically analyze the temple's architectural features through a multi-criteria evaluation framework. These features are assessed using intuitionistic fuzzy value of lexicographic order and weight values using the Rank order centroid approach by integrating the method, the values are prioritized and weight of the criteria is evaluated, also the outcome is compared using the vague Intuitionistic fuzzy set multicriteria decision. The method is used to assess major structural components of the temple is reveal and demonstrate the strength of the Dravida structure of the Chola reign temple.

Keywords: Intuitionistic fuzzy value, lexicographic order method, Rank order centroid.

关键词：直觉模糊值、词典序法、排序中心法。

Introduction

It is widely recognized that decision-making is done precisely in today's world mostly for their legacy and for commercial works. Chola Temple is one instance of a heritage period that remains firm in relation to both culture and design as well as essential necessities. provide financial assistance to our culture and people in the modern lifestyle. This study uses the MCDM multi-criteria decision-making with institutional fuzzy set to answer the structure feature of the temple and the myth that the ancient parents predicted. It is solved using the MCDM multi-criteria decision-making with an intuitionistic fuzzy set, where it made a comparison with a vague fuzzy set, an extension of a fuzzy set[Chen, S. M., Tan, J. M,1994] [Hong, D. H.,Choi, C. H. 2000], and the lexicographic method for the ranking process.

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A vague set is an extension of a fuzzy set, tracing the evolution from fuzzy sets to interval-valued sets and then to vague sets in decision -making [Chen, S. M.,Tan, J. M, (1994], showing how each step tries to better represent uncertainty and evidence. It was introduced by Gau and Buehrer [Gau, W. L., Buehrer, D. J, 1993] and consists of truth membership and false membership, where The vague set is used here because the fact that is believed has a scientific reason, explained using the truth membership and false membership functions, whereas the false membership is termed as derived from the truth membership. The lexicographic preference, or lexicographic order, in decision-making is used for weight assessment. This method was proposed by Georgescu-Roegen N. in 1954[Safarzadeh, S.,Rasti-Barzoki, M. 2018] and later extended and followed by Encamacion in 1964[Safarzadeh, S., Rasti-Barzoki, M,2018]. It is in the form of a ranking method from higher to lower, whereas for lexicographic presence, the ranking is done with the weight aggregate, and it is evaluated using the rank order method. Lexicographic fuzzy sets and vague fuzzy sets follow the same process, although their formulas and approaches are different. The paper illustrates both approaches via the monumental construction of Chola and a Tamil Nadu architectural masterpiece. The vague fuzzy set procedure is applied in the first session, followed by the lexicographic method and its ranking using the Rank Order Centeriodin the second session, and the core area where evidence for its familiarity with common people, religious people, and myths is determined in the final session.

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Objective

- To compare the architectural elements of Chola temples and use the lexicographic method to rank the structure features of these temples under uncertainty.
- To analyze Chola temple features in a position of uncertainty by noting the amount of support and opposition for each criterion, providing a more flexible and realistic architectural assessment.

Notations and Concepts

Definition

D1:

An Intuitionistic fuzzy set (IFS) I in S is defined as an object of the following form I = {x, $\mu_I(x)$, $\gamma_I(x)$: x ∈ S} where the functions: $\mu_I : S \rightarrow [0,1]$ and $\gamma_I : S \rightarrow [0,1]$. Define the degree of membership and the degree of non-membership of the element x ∈ S, respectively, and for every x ∈ S $0 \leq \mu_I + \gamma_I \leq 1$.

D2: [Chen, S. M., & Tan, J. M,1994] [Hong, D. H.,Choi, C. H. 2000]

Let U be a universal set. A vague set A in U is defined by two functions $t_a(x)$: The truth-membership function (degree of evidence for x belonging to U, $1- f_a(x) = t_a^*$ The false-membership function (degree of evidence against x belonging to a. the vague set functions must satisfy $0 \leq t_{fa}x + f_{fa}x) \leq 1, \forall x$

The grade of membership of x in vague set A is not a single value but an interval

$$[t_{fa}x , 1 - f_{fa}x] \quad (1)$$

This interval gives a more nuanced understanding of uncertainty. Where $1 - f_{fa}x$ defined as $t_{fa}x^*$.

D 3. [Xu, W., Ma, J., Wang, S., Hao, G,2010]

Let x and y be two vague values, $x=[t_a x ; 1- f_a x]$ and $y=[t_a y ; 1- f_a y]$, where $t_a x \rightarrow [0,1]$ $t_a y \rightarrow [0,1]; f_a x \rightarrow [0,1]$ $f_a y \rightarrow [0,1]$; and $t_a x + f_a x$. The result of the maximum operation of the vague values x and y is a vague value c, written as $c=a \vee b = [t_a x ; 1- f_a x]$,where $t_a x = [(t_a x, t_a y); 1- f_a x = max[1- f_a y, 1- f_a y)]$

The degree of importance is criteria presented by the decision making with weight $W_1, W_2, \ldots W_j$ respectively where $Wj \in [0,1]$ and $\sum Wj = 1$ then the degree of suitability for the alternative is given as

$W(A)_j = Max[S([t_{f1a}x , t_{f1a}x^*]) * W_1) + S([t_{f2a}x , t_{f2a}x^*]) * W_1) \ldots + S([t_{fja}x , t_{fja}x^*]) * W_j) = p_j$ (2)

$$W(A)_j = p_j \quad (3)$$

D4 The union of the vague sets A and B is a vague set C, written as $C = A \vee B$, whose truth membership function and false-membership function are t_{aC} and f_{aC}, respectively, where $\forall u_i \in U$,

$t_{aC}u_i = (t_{a_1C}u_i, t_{2C}u_i)$ $\quad 1 - f_{aC} = max t_{a_1C}u_i, t_{2C}u_i)$: $\forall u_i \in U$

$$[t_{aC}u_i, 1 - f_{aC}] = [t_{a1C}u_i, 1 - f_{a1C} \vee [t_{a2C}u_i, 1 - f_{a2C}]$$
$$= [(t_{a_1C}u_i, t_{2C}u_i), (f_{a_1C}u_i, f_{2C}u_i)] \quad (4)$$

D6: [Chen, S. M., & Tan, J. M,1994] [Hong, D. H.,Choi, C. H. 2000]

The score function is a mapping s : $L_g^* \rightarrow [0,1]$ given by

$$S_f(a) = S_{fa} = t_{fa} - f_{fa} \; \forall \, a = (t_{fa}, f_{fa}) \in L_g^* \quad (5)$$

D7: [Chen, S. M., & Tan, J. M,1994] [Hong, D. H.,Choi, C. H. 2000]

The accuracy function is a mapping $h_f : L_g^* \rightarrow [0,1]$ give by

$$H_f(a) = H_{fa} = t_{fa} + f_{fa} \; \forall \, a = (t_{fa}, f_{fa}) \in L_g^* \quad (6)$$

D8: [Chen, S. M., & Tan, J. M,1994] [Hong, D. H.,Choi, C. H. 2000]

Let $a = (t_{fa}, f_{fa})$ and $b = (t_{fb}, f_{fb})$ be two IFVs. Then a, b ∈ L_g^* can be compared as follows

If $S_{fa} < S_{fb}$ a is smaller than b and denoted by $a < b$
If $S_{fa} = S_{fb}$, then we have (7)
If $h_a < h_b$ is equivalent to b and denoted by $a = b$
If $h_a = h_b$ is equivalent to b and denoted by $a < b$

If $h_a > h_b$ is equivalent to b and denoted by $a > b$

D9

Sum Aggregation without Weights in IFS

Let (μ_i, ϑ_i) i=1,2, …, n_i be a intuitionistic fuzzy values each characterized by membership and non-membership degrees. The non-weighted sum aggregation is defined and it is a basic essential aggregation approach for membership and non-membership values

$$(\mu_{total}, \vartheta_{total}) = (\sum \mu_i \sum \vartheta_i) \quad (8)$$

D10

The Rank Order Centeriod $\sum w_j = \frac{1}{n}\sum_j^k \frac{1}{k}$ is defined for sun evaluation

$$L = \frac{H}{TanE} \quad (9)$$

Where Tan E is $90^0 - |latitude - \delta|$ $\forall \delta \delta$ *sun Declination.*

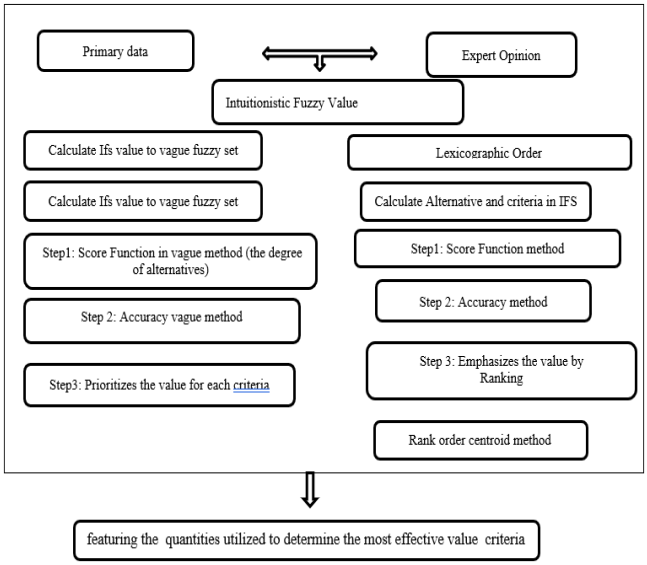

Figure 1: Process for the decision-making technique Flowchart for the construction

Technique

- Acquire the linguistic value from the expert for the criteria and alternatives
- Adhere the Flow Chart
- A Quantifiable Preference for the construction of the temple in the Dravida form has been assessed.
- Flowchart for the construction

Utilizing the technique

A study

The aforementioned technique and flowchart [figure 1] were implemented to determine to rank and prioritize the structure features of the Chola Dynasty's Dravida-style temple. here the Brihadeeswarar Temple structure the main shrine -vimana, mandapa, sculptures are considered her as alternatives and Ornamentation Quality (OQ), Spatial Symmetry (SS), Structural Stability (ST), Iconographic Accuracy (IA)and Artistic Uniqueness (AU) are considered as criteria. The scoring function is the same for both the lexicographic method and the vague fuzzy set unless related to the accuracy in the vague fuzzy set, non-membership is characterized as $1-f_a$. Conversely, the lexicographic technique defines non-membership radically. The weight of criteria is obtained from the expert for each alternative [0.30, 0.25, 0.20, 0.15, 0.10]. After analysing these choices

Figure 2: Brihadeeswarar temple build by chola's [Indian Contents, 2020]

and criteria using two distinct methods and looking at the outcomes, we offer the best evaluation technique. via implementation a numerical sample of historic temples.

The application of the technique in chola monarch temple (Figure 2), Later, the Pandya's repaired the Nandi and urbanized the Cholas structure with adequate reverence to Lord Shiva.

The domestic variable of IFS value is now process with flowchart for both vague set ranking (Tables 3, 4) and lexicographic set Tables 6, 7, 8 consists accuracy and Score formulae.

In the span of Ranking, higher values are used in the given, whilst negative values are by default regarded as the lowest values.

Working with the lexicographic Intuitionistic Fuzzy set, one can tackle the identical alternative and criteria values, with weights determined through the Rank Order Centroid (ROM).

Table 1: Table is of Expert Alternatives and criteria

Alternatives \ criteria	*OQ*	*SS*	*ST*	*IA*	*AU*
vimana	Exceptional	High	Excellent	Excellent	Good
Mandapas	Excellent	Excellent	Exceptional	Exceptional	Exceptional
Structure	High	Exceptional	High	Excellent	Excellent

Table 2: Linguistics to Intuitionistic Fuzzy Value

Alternatives\ criteria	*OQ*	*SS*	*ST*	*IA*	*AU*
Vimana	(0.21, 0.05)	(0.39, 0.75)	(0.43, 0.1)	(0.43, 0.1)	(0.30, 0.06)
Mandapas	(0.43, 0.1)	(0.43, 0.1)	(0.21, 0.05)	(0.21, 0.05)	(0.21, 0.05)
Structure	(0.39, 0.75)	(0.21, 0.05)	(0.39, 0.75)	(0.43, 0.1)	(0.43, 0.1)

Table 3: convert IFS into Vague Set of IFS from equation:1-degree of truth value (eq:1)

Alternatives \ criteria	*OQ*	*SS*	*ST*	*IA*	*AU*
Vimana	(0.21, 0.95)	(0.39, 0.25)	(0.43, 0.9)	(0.43, 0.9)	(0.30, 0.4)
Mandapas	(0.43, 0.9)	(0.43, 0.9)	(0.21, 0.95	(0.21, 0.05)	(0.21, 0.95)
Structure	(0.39, 0.25)	(0.21, 0.95)	(0.39, 0.25)	(0.43, 0.9)	(0.43, 0.9)

Table 4: From using equation: (eq:2) -the degree of suitability (eq: 3,4)

Alternatives\ criteria	*OQ*	*SS*	*ST*	*IA*	*AU*	*Pj*	*Ranking*
Vimana	0.099	0.0825	0.024	0.072	0.021	0.1125	2
Mandapas	0.099	0.0825	0.032	0.024	0.016	0.2535	1
Structure	-0.072	0.024	0.036	0.0825	0.099	0.0975	3

Table 5: The Sum Aggregation without Weights in IFS

Alternatives \ criteria	*OQ*	*SS*	*ST*	*IA*	$(\mu_{total}) = \Sigma \mu_i)$	$(\vartheta_{total}) (\Sigma \vartheta_i)$
vimana	(0.21, 0.05)	(0.39, 0.75)	(0.43, 0.1)	(0.43, 0.1)	1.76	1.06
Mandapas	(0.43, 0.1)	(0.43, 0.1)	(0.21, 0.05)	(0.21, 0.05)	1.49	0.4
Structure	(0.39, 0.75)	(0.21, 0.05)	(0.39, 0.75)	(0.43, 0.1)	1.85	1.75

Table 6: The lexicographic method for the given IFS value by the expert and solved using [eq: 5,6,7]

	Membership	*Non-membership*	*Score function*	*Accuracy*
Alternatives\ criteria	(μ)	(ϑ)	(H)	(D)
vimana	1.76	1.06	0.70	2.81
Mandapas	1.49	0.4	1.09	1.89
Structure	1.85	1.75	0.10	3.6

Table 7: Ranking order method for Ranking the table

	Membership	*Non-membership*	*Score function*	*Accuracy*		
Alternatives\ criteria	(μ)	(ϑ)	(H)	(Å)	ROC	Ranking
vimana	2	2	2	2	2.00	2
Mandapas	3	1	1	3	1.84	1
Structure	1	3	3	1	2.17	3

Table 3 provides the IFS value of membership, which is then transformed using the fuzzy preference method by eq: 9

For the rank order method, the provided criteria's weights are arranged as : $H > Å > \mu > \vartheta$.

Result and Discussion

In the preceding table, there is a tie after the rank order approach has been implemented. The Rank Order Centroid uses a percentage-based top rank criteria, arranging items from lowest to highest, with the mandapas positioned at the top and allowing for the evaluation of the myth. "The Shadow does not fall on the ground at noon" has been resolved using [eq:9] and the Zenith Angle for [figure 1] has been employed to solve this from [eq: 9]

$$L = \frac{H}{TanE}$$

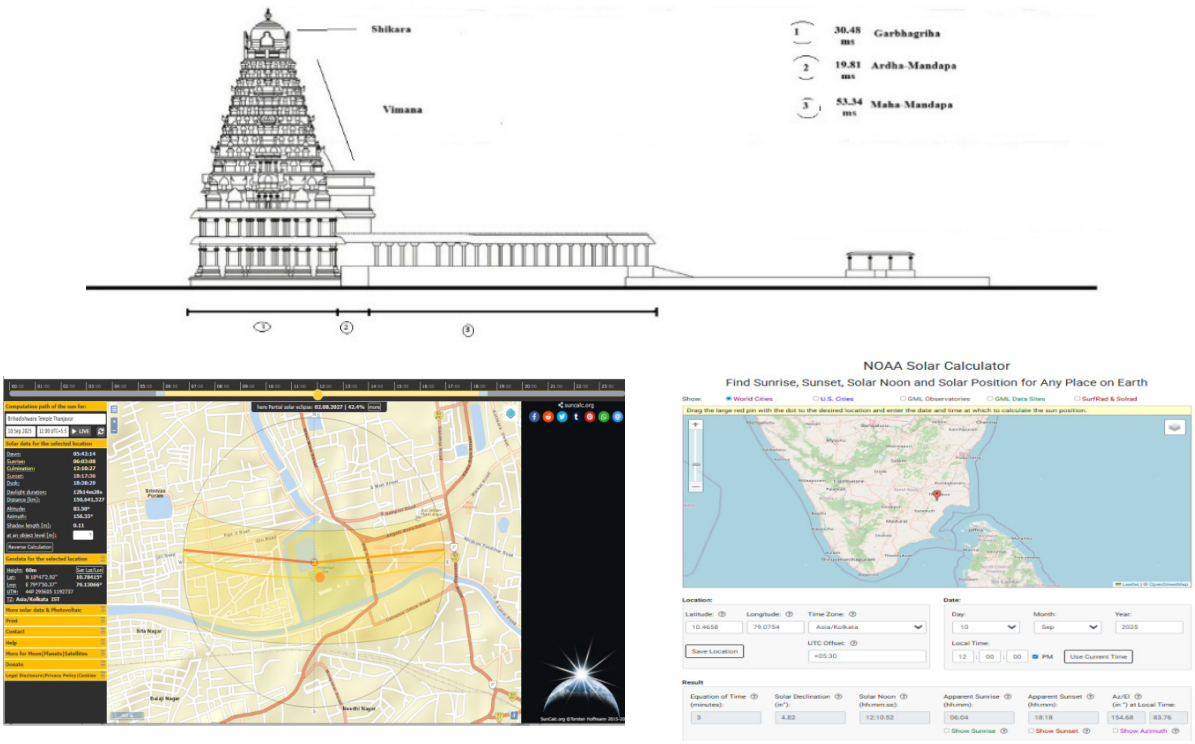

Figure 3: Sun calculation [Vatsyayan,2012] and latitude value in NOOA calculation for δ value and shadow calculation for temple

The latitude value for brihadeshwara temple is 10.76 and given δ change according to sun rise where it is calculated using sun-calc.

The main shrine consists of garbhagriha, an ardha-mandapa and a mahamandapa. The base of the horzontial structure is has 3 phrase - Shikar (cup shape),vimana(linear), grabhagriha (square shape). grabhagriha lower position of vimana that touch the surface.In addition to having the same width, the garbhagriha and mahamandapa measure 30.48 meters (100 feet) and 53.34 meters (175 feet) in length, respectively. The ardhamandapa has a side of 19.81 ms (65') and is shaped like a narrow square neck between the two [3] [4][5]. At 12 noon the ä is -5.32° (5.32 south celestial equator)

$$L=\frac{H}{TanE}=\frac{66\ m}{84^0.86\ m}=2.52\ feet$$

And for solar altitude we get solar altitude = $\theta_z=|\varphi-\delta|=\frac{H}{Tan\theta_z}$

The solar altitude = $\theta_z=|\varphi-\delta|=16.1^0=73.9=\frac{H}{Tan(73.9)}=17.6ms$

Hence the shadow at 12 noon it falls exactly on Ardhamandapa itself

Conclusions

On the whole, it can be determined that the decision-making process that Mandapas are essential to the Dravida style of the Chola temple. Ultimately, the myth is additionally resolved. An approach of analysis using the lexicographic method is superior to the vague fuzzy set technique. This process demonstration reveals a solid foundation for the Chola temples as a real-life example, illustrating the reason the grandeur of the Brihadeeswarar temple has been summed up. For the future, this approach may be extended to other Chola temples built in the Dravida style, as well as Nayaka's and other structures.

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