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Application Of Analytical Hierarchy Process In Construction Of Residential Building Project

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Abstract:AHP helps decision-makers to choose the most suitable alternative from several options and selection criteria. Thomas Saatyinvented the AHP as a decision-making tool in the late 1960s. This paper presents the Analytical Hierarchy Process (AHP) as an effective tool to be used in various project management applications. The paper consist in elaborating the process by working out its applications in various activities of construction and proving its suitability to be used in construction industry. The process will be applied in the various situations of construction execution where a condition may be created that numerous competitive ways are available, & hence is a confusing moment of selecting the most optimum way, giving it a concrete solution. Different activities during residential project planning such as selection of site, selection of professionals, material suppliers, etc. are worked out by using AHP, hence giving numerical priorities to all the available alternatives. Then a straightforward consideration can be given to the alternatives having highest numerical weightages. Apart from this, while working on the different alternatives of a particular problem statement, all the parameters which affect each and every alternative are considered and also pairwise preference among these parameters is done. Thus the final output of above process, i.e. the selection of the most suitable alternative, will prove to be worth reliable to act upon. However, the ultimate aim of the attempt is to put the lights on the use of AHP in residential construction project management and to have a social awareness about the same. It is hoped that this will encourage the application of the AHP by project management professionals.

Keywords: Analytical Hierarchy Process, hierarchy structure, consistency ratio, priorities weightage, pairwise preference.

I.INTRODUCTION

Many a times in construction industry while accomplishing numerous activities one has to face the conflicting and confusing situation regarding the selection, rather finalizing a certain appropriate decision. Thinking over of the entire parameters one can overcome the situation, however we don't have a concrete proof regarding the exactness of selection. Above all there may be the chances of failure. Hence to simplify these critical situations by analysing the parameters affecting the selection, the 'Analytic Hierarchy Process' is utilized.

The analytic hierarchy process (AHP) is a well-designed process for simplifying and analysing critical decisions by using a mathematical analysis. It is used around the world in a wide variety of decision situations, in fields such as government, business, industry and education. The decision-makers first convert their problem statement into a hierarchy of more easily comprehended parameters known as elements of the hierarchy, each of which can be analysed separately. After building the hierarchy, the user systematically evaluate the various elements by pairwise comparing them to one another, two at a time, depending on their effect on an element above them in the hierarchy. The process is having wide scope of applications and

also research in the fields like priority fixation, profit optimisation, sequential operation, resource allocation, human resource selection, capital utilisation, method study and time study and its optimisation, etc.

The process aims at providing equivalent priorities for a given number of alternatives on a ratio scale, depending on the experience of the decision-maker, and alights the importance of the intuitive sensible conclusions of a decision-maker as well as the consistency of the comparison of alternatives in the decision-making process

II.PROCESS IMFORMATION

As developed by T. L. Saaty the process for AHP can be worked as below [4]:

1. Initially determine the problem statement for AHP and the available alternatives for the same.
2. Structure the hierarchy into three levels from top to bottom. The top level consisting of the goal to be achieved, the middle level will comprise of the criterions depending on which the problem is to be solved. Ultimately the third level will contain the available alternatives for the problem out of which one will be the final solution. The hierarchy structure is as shown in the figure below

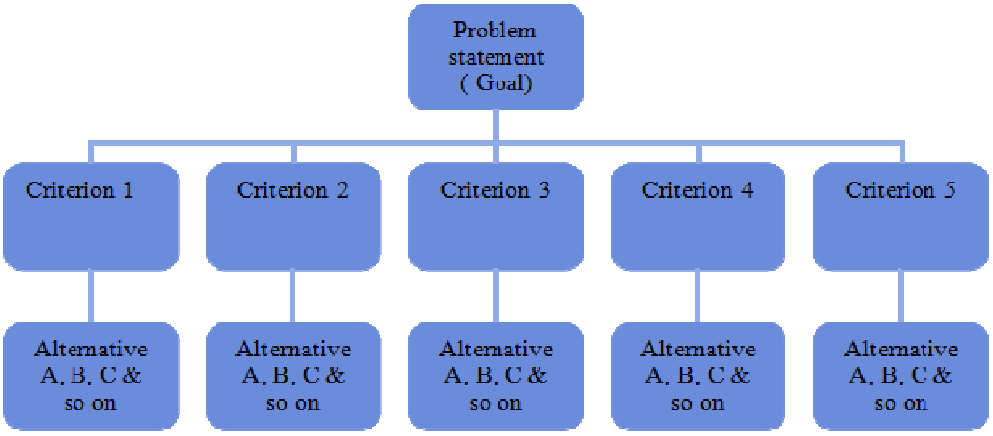

Fig1: Sample Hierarchy Structure

3. Now from the criterions available, carry out the pairwise preference of each criterion with one another using the comparison score between two criterions from 0 to 9. This score resembles the dominance of one criterion over the other. The meaning of each score is given in the table below.

Table 1 Pairwise Preference (24)

Numerical score	**Judgement**
9	Extremely preferred
7	Very strongly preferred
5	Strongly preferred
3	Moderately preferred
1	Equally preferred

4. With the provided preferences from previous step the matrix is prepared and these preferences are assigned in the upper triangular matrix. The lower triangular matrix is filled with the reciprocals of the values assigned in upper one.

5. From the above synthesized pairwise preference matrix the priority vectors are prepared. Using this the weighted eigen vectors of each alternatives are determined. From this eigen vectors the equivalent eigen values for each alternative is calculated.
6. Having made all the above calculations, the consistency index are calculated by using the eigenvalue, E, to calculate the consistency index as follows:

$CI = (E - n)/(n - 1)$

Where n is the matrix size.
Following this the Random Index is determined from the table given below

Table 2: Average random consistency index (RI) [4]

Size of matrix	1	2	3	4	5	6	7	8	9	10
Random index	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49

Judgment consistency can be checked by calculating the consistency ratio (CR) as below:
CR = CI/RI
The CR is acceptable, if it does not exceed 0.1. If it is more than 0.1 then the judgment matrix is inconsistent. To obtain a consistent matrix, judgments should be reviewed and improved.

III.METHODOLOGY

A structured questionnaire survey with various planning and design engineers further helped to conclude that the use of AHP in the planning and execution of a residential construction project will prove to be a beneficial approach for all the management and planning consultants. So with the above reference the Analytical Hierarchy Process is applied to a residential construction project in Nashik, Maharashtra, India.

A residential project named 'SHRI SAI APARTMENT' executed by a private firm Nirmiti consultants is owned by Er. Mr. Sanjay Dhotre, and is located at Janta raja colony, dattanagar, Panchavati, Nashik, Maharashtra, India. The apartment consists of a G+3 storeyed RCC building with luxury class construction amenities and facilities. The total area of plot is 515 yards i.e 427 square meter. The gross builtup area of the structure is 9000 square feet. The building is located in a well developing area with all the civic facilities available, like roads, water supply and drainage, electricity connectivity etc. The construction of RCC frame work and wall masonry is completed however the structure is at the finishing stage.

For the above project an attempt is made to use the AHP for the decision making situations as below:

1) Selection of Site
2) Selection of Structural designer
3) Selection of Contractor
4) Selection of RMC plant for procurement of concrete

The above fields of application are finalised as per the questionnaire made with the owner of the project Architect Mr Sanjay Dhotre. As seen in the above context the procedure for use of AHP as suggested by T. L. Saaty, the above factors are worked using AHP.For using AHP for selection of site, first of all we have to determine the criterions using which the alternatives would be worked out. Hence the following will be the criterions for the selection of site for

residential building project:Shape of plot, Location of plot, Civic services, Surface soil, Dominance by adjoining structures.

So with respect to above criterions the available alternatives namely Site A (At jantaraja colony, Nashik), Site B (At pethroad, Nashik) and Site C (At Hirawadi, Nashik), the AHP is carried out using the standard procedure. The hierarchy structure prepared for selection of site is as below:

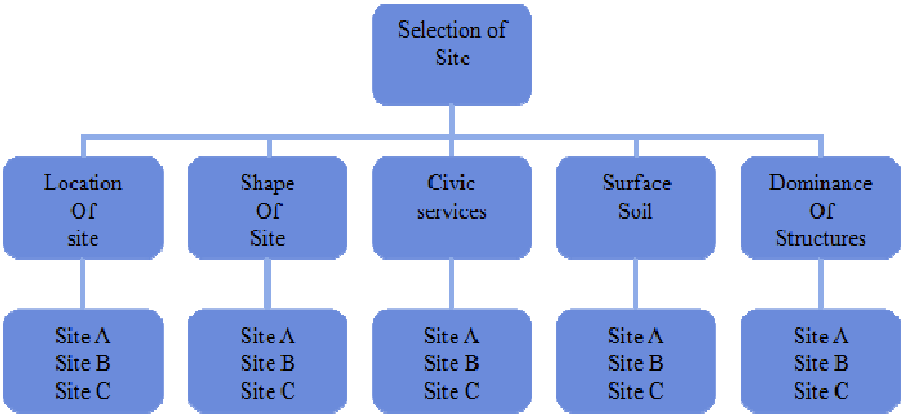

Fig 2: Hierarchy for selection of site

IV.RESULTS AND DISCUSSION

After applying AHP the check for consistency ratio as illustrated above is satisfied and the calculated priority vectors are as shown in the bar chart below

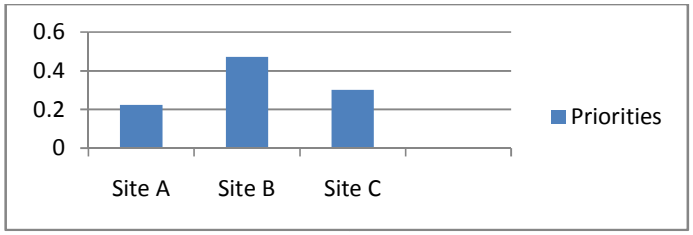

Fig 3: Priorities weightage for selection of site

From the above bar chart it can be concluded that the Site B was the most suitable site to be selected. In similar manner the same process was applied to other fields such as selection of structural designer, contractor and RMC plant for concrete procurement. The Priorities of the available alternatives of all the problem statements as calculated is summarised in the bar-charts shown below:

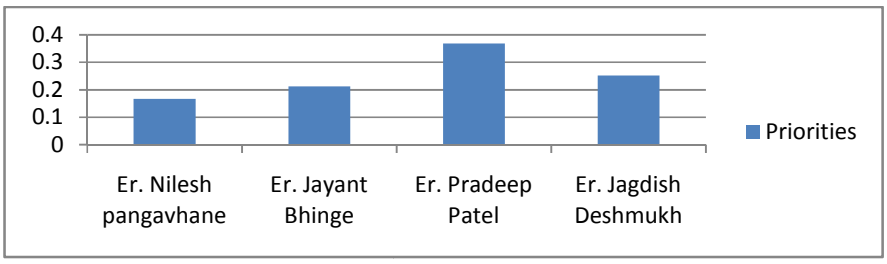

Fig 4: Priorities weightage for selection of structural designer

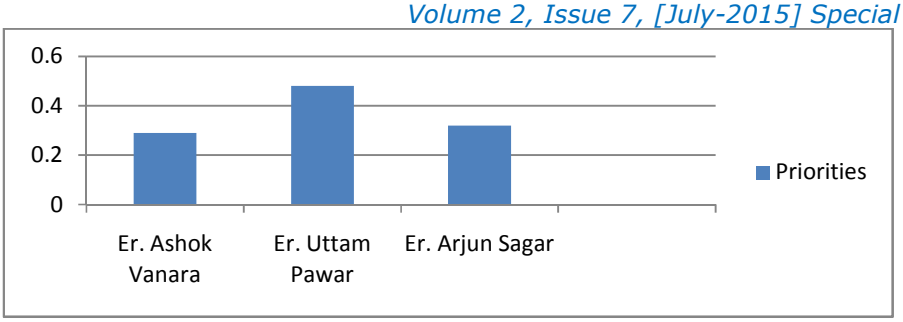

Fig 5: Priorities weightage for selection of contractor

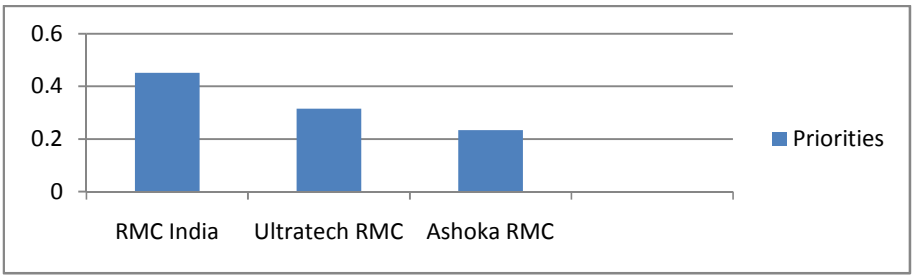

Fig 6: Priorities weightage for selection of RMC plant

Thus from the above analysis and its summarised bar charts, the alternative to be opted for a given problem can be easily determined. For selection of Structural designer, Er. Pradeep Patel is the best suited one. Again for selection of contractor Er. UttamPawar is the most suitable option and also for selection of RMC plant, RMC India is the best option. These are interpretations given by the AHP solution for the above problems.

V.CONCLUSION

Thus from the above applications of AHP we can conclude that the use of process is totally based on the criterions which widely affect the selection of the alternatives. Also the pairwise comparison between the alternatives and criterions play a vital role to get the ultimate output. The results in the form of priority weightages are much clear to indicate the selected alternative, alongwith a concrete numerical proof for the responsibility of selection for success of project.

AHP is a worth applicable and reliable process to simplify a complicated situation into an easily understandable manner. The Analytic Hierarchy Process (AHP), is an effective tool for dealing with complicated decisions, and may assist the decision maker to set primacies and make the best decisions. In addition, checking the consistency of the decision maker's evaluation is also incorporated by AHP. Any complex situation that requires organizing, measurement, and synthesis is a good candidate for AHP.

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