COMPARISON OF DIFFERENT CONSTRUCTION TYPES FOR RESIDENTIAL BUILDING USING THE ANALYTIC HIERARCHY PROCESS

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Abstract

In the field of Construction Management (CM), the ***Analytic Hierarchy Process (AHP)*** is becoming more and more popular as a tool for deciphering difficult circumstances and arriving at wise judgments. Building construction is a multifaceted and intricate profession. Numerous factors, including economics, design, environment, and building type, impact the selections. Application of mathematical models should be taken into consideration in order to clarify the decision-making process and identify the essential quality aspects. A multicriteria analysis approach has the benefit of taking into account several of these performance criteria at once, bridging over multiple domains of knowledge. It also offers the option of balancing the several standards with regard to a particular construction and design environment. The results showed that the most often used AHP application areas in CM were risk management and sustainable building. It was also discovered that AHP is adaptable and may be utilized to handle construction decision-making issues either alone or in combination with other tools. Furthermore, it was shown that the most common reasons for utilizing AHP were its small sample size, high degree of consistency, simplicity, and accessibility to user-friendly software. For academics and practitioners interested in using AHP in CM, this paper offers a helpful resource. It will be helpful to do further study to compare and contrast AHP with other multicriteria decision-making procedures. This will help identify which approaches yield optimal answers in different decision-making settings..

Keyword: Analytic Hierarchy Process (AHP), Multicriteria Decision-making application, Construction Management.

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1. Introduction

The competitive nature of the construction business is causing construction companies to prioritize project schedules and costs over project quality. Analyzing the relative weight that construction businesses assign to cost, time, and quality is crucial to comprehending current market conditions. Each project will vary in its scope and priority according to a variety of circumstances, such as the project's location, kind, and scale. Every construction project involves a variety of personnel from various professions as well as various degrees of workers of a construction firm. They all contribute to the project in different ways so that it is effectively completed. Additionally, they could all hold distinct philosophies and viewpoints on certain topics. Due to its distinct character, the construction sector is often challenging compared to other industries. Every project is unique and involves a wide range of unreliable parties. Three factors govern project control: money, time, and quality. It's critical for project managers to comprehend their point of view in order to determine what has to be changed and where.

1. To offer a theoretical explanation on resources throughout construction management with particular attention to water, land, machinery, space & amenities, and human resources in addition to material resources.
2. To study and analyze the literature and research that are currently accessible on resource management in the construction industry, with a focus on identifying gaps for the purpose of creating an agenda for future research and prioritizing the use of various resource characteristics based on the kind of project.
3. To assess the criteria for managing resource demands (land resources), with a focus on cost, quality, as well as time. Resources (people, materials, water, machines, space, and facilities) in relation to the building, road, and bridge construction variations taken into consideration for the current research using the AHP technique
4. To draw conclusions and offer helpful recommendations for resource management in the aforementioned projects, as well as alternative initiatives in the construction sector, with the goal of boosting the effectiveness of resource usage in the aforementioned projects.

2. Analytic Hierarchy Process (Ahp)

AHP is the main structured method of influence in the decision-making process. Thomas L. Saaty created this procedure in the 1970s, and its primary purpose is to analyze numerous judgments made by various individuals. It is frequently used to address issues efficiently and develop a rationale for strategy. Understanding and analyzing the irrational judgments made while selecting a response from a list of options that have been evaluated based on a number of factors is helpful. In research, AHP is a quantitative and qualitative study that links an individual experimental question to the circumstance. AHP use the qualitative method to systematically restructure issues into a hierarchy. In parallel, a questionnaire is used to compare the pair-wise matrix quantitatively and obtain more consistent replies and judgments. AHP is often a mathematical technique built on matrices algebra. It is employed as a strategy to acknowledge the significance of variables in decision-making or resolving issues to complete a task.

With this method, the analyzer primarily extracts the basic Pairwise matrix from the choices or answers provided by various participants. They play a major role in establishing the relative ranks of the available options. The process begins with the creation of alternative alternatives, followed by the definition of values and criteria, option evaluation, and option recommendation. Any factor of a decision problem, whether physical or ethereal, exact or approximative, can be included in the hierarchy. Over the whole problem range, the AHP will compute and convert to numerical values that are well-defined and comparable.

3. Ahp Steps

The analytical hierarchy process (AHP) is an analytical technique for generating and assessing difficult choices, based on mathematics and psychology [4]. This idea, first proposed by Thomas L.Saaty in the 1970s, has been the subject of intense research and development ever since [4]. Governments, corporations, the healthcare, shipbuilding, and academic fields all utilize it when making complicated decisions. Instead than prescribing a single "correct"[4] course of action, AHP guides decision-makers toward the option that best fits their goals and their comprehension of the issue at hand. It gives a thorough and balanced framework for developing a choice for the issue, for expressing and characterizing its components, for linking those components to the overall purpose, and for investigating alternate solutions. In order to use the AHP effectively, users must first segment their issue into progressively smaller, more [4] manageable subproblems. The elements of the hierarchy might be related to any aspect of the issue, whether it is concrete or abstract, thoroughly investigated or simply approximated. Following the establishment of the hierarchies, the decision-makers conduct a thorough analysis of the different parts by contrasting them with one another in terms of the effect they have on the part above them [6].
While making comparisons, the decision makers may utilize precise information about the components, but generally they use their judgments

about the components' relative significance and relevance [6]. The AHP relies on expert opinion rather than cold hard data alone [4] in order to make its evaluations. To facilitate processing and comparison across the whole scope of the issue, the AHP converts these assessments to numerical values [4]. Different and frequently dissimilar parts may be compared to one another in a fair and consistent manner when numerical weight ages or priorities are specified for each component of the hierarchy [6]. Compared to other methods of decision making, this is what sets the AHP apart [4]. The AHP consists of three steps:

(1) hierarchy formation - The decision objective is at the top of the decision tree, while the criteria, sub-criteria, and options for accomplishing that goal are progressively broken down to lower levels.
(2) pairwise comparisons - Participants in the decision-making process (often subject matter experts) are requested to conduct pairwise comparisons of the items at each level of the hierarchy, under the assumption that they are unrelated. To this end, and in light of the decision's ultimate purpose, we compare the weights of all pairs of criteria at the second level of the hierarchy. Level two comparisons are made between every pair of sub-criteria that make up the same criterion, and so on.
(3) verification of consistency - To weigh each criteria and every potential path forward in pursuit of the decision's objective, expert opinion is required. Due to the subjective nature of AHP, there is no assurance that decisions will be consistent. Therefore, it is crucial to verify consistency in order to guarantee the best possible result.

4. Results and Discussion

Priorities of the chosen standards following the collection of expert viewpoints, we grouped them according to the specialties of the experts: wood technology, building, and architecture. Experts in the same field are expected to make similar decisions. This supports the use of the geometric mean approach. The evaluations of the groups were recorded in comparison matrices. Priority vectors for six predefined criteria for comparing matrices of three regions were generated using the eigenvalue technique. By using the consensus model on the priorities vectors of the three regions, the final group priorities were determined. Table 1 lists the group priority for each of the criteria.

“Table1-Quality rank.

	Wood technology engineers	Architect engineers	Construction engineers	Consensus	Rank
Quality of Life	0.31	0.33	0.38	0.34	1
Construction Costs	0.25	0.14	0.15	0.18	2
Construction time	0.10	0.06	0.04	0.07	6
Depreciation Costs	0.19	0.12	0.20	0.17	3
Design	0.11	0.25	0.09	0.15	4
Embodied Energy	0.05	0.09	0.14	0.09	5

Stepping out and scored top among the criteria is quality of life (w = 0.34). The criteria of deprecation costs (w = 0.17) and design (w = 0.15)” come in second and third, respectively, after the building costs (w = 0.18). Construction time is placed last (w = 0.07) while the embodied energy criteria is ranked fifth (w = 0.09).

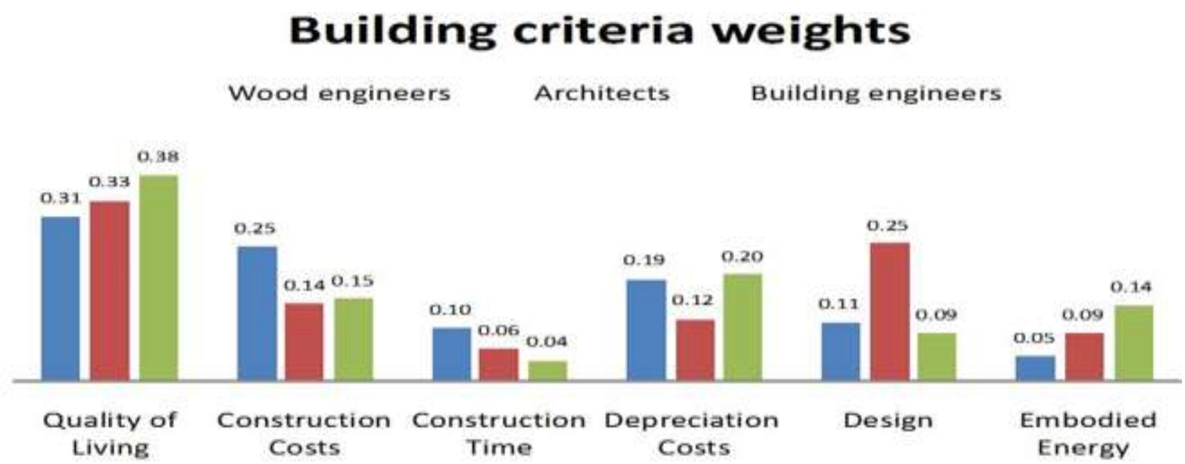

Figure 1-Comparing the criteria.

The survey responses from three subsets of engineers are compared in this figure (Fig. 1): construction engineers, architectural engineers, and wood-technology engineers. Among the experts in the field, the group of architects and engineers stood out because they assigned a higher rating to the design component than the other specialists.

Results of the Decision Tree

Weights of significance for every criterion and option are combined individually in the decision tree. The criteria vector of priorities and the matrix multiplying of other values yielded the priorities for each building type (alternative). The selection of process for constructing a home is shown in Figure 2, with wood frame structures receiving the greatest priority and buildings made of steel receiving the lowest.

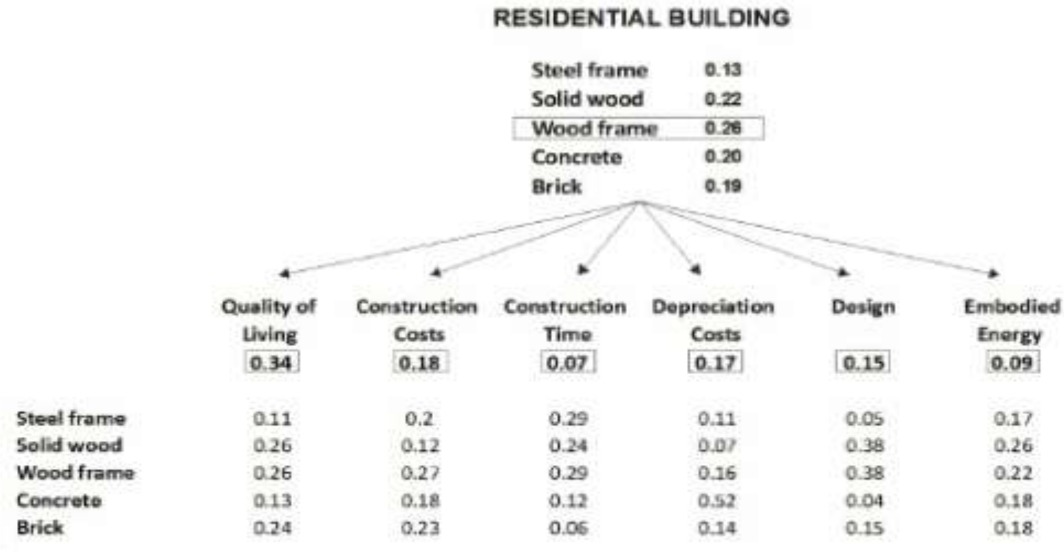

Figure 2-The decision tree for residential building.

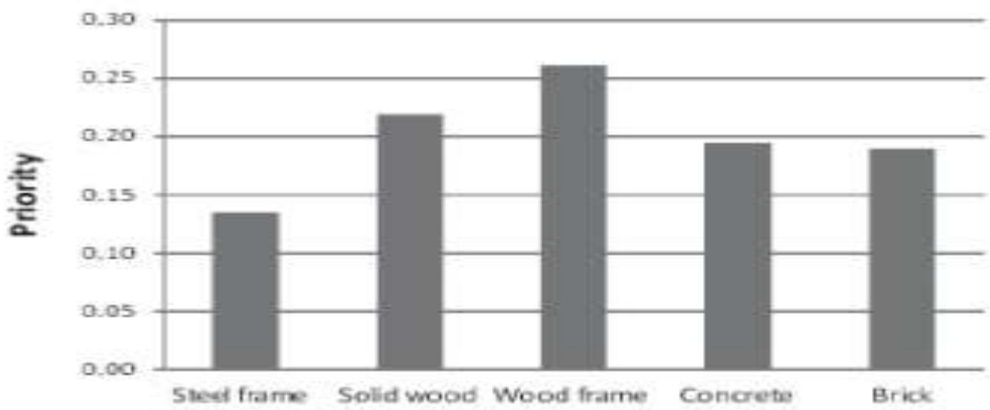

Figure 3-The ultimate rankings of several building kinds for residential construction

In Figure 3 we can see the ultimate order of importance for the different sorts of structures. Wood frame construction is highly valued (w = 0.26), followed by solid wood structure (w = 0.22), and then virtually tied for third place by concrete and brickwork (w = 0.20, w = 0.19). The steel frame construction (w = 0.13) obtained the lowest score. The outcome was anticipated as there is a growing trend toward low-carbon timber construction, which is a crucial foundation for low-energy and low-emission buildings with excellent qualities related to wellness and security. An increase in timber use during construction can lower the building's carbon impact.

5. Conclusion

Our study demonstrated the use of the Analytic Hierarchy Process (AHP) approach to analyze the residential building-related decision criteria. In addition to load capacity, energy efficiency, and fire safety, the analysis revealed that quality of life, construction cost, and depreciation expenditures are the most influential elements. Wood-frame construction was determined to be the best suitable for residential structures with different criteria after being compared to other construction techniques. Because it is a natural raw material and has strong mechanical qualities, as well as being an effective thermal insulator and guaranteeing a suitable indoor atmosphere, wood is one of the greatest options for energy-efficient building. It ought to be pointed out that not many buildings are constructed entirely of one material. Positive, reasonable construction practices should combine the use of suitable substances as well as technology. In the future, this type of analysis will determine the strong and weak points of wood building, which can provide a new perspective on how best to promote and market wood buildings by enabling professionals to make more informed decisions regarding the optimization and development of specific building process aspects. Through this process, professionals can compare various alternatives on an average and thorough basis.

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