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The Analytic Hierarchy Process as a Decision-Support System in the Housing Sector: A Case Study

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Abstract: Analytic Hierarchy Process (AHP) is a decision based on mathematics and human psychology algorithm which is developed by Dr. Saaty. It has many applications as documented in Decision Support System literature. The importance of decisions in the housing sector is reflected in the magnitude and nature of the housing problem in Worldwide, building material, contraction technology and skill manpower within urban and rural area to meet existing housing needs. In present, within the India 2.47 crores houses are shortage and will increase drastically in future. The overall objective in selecting a housing scheme is the affordable to the different income group. Obviously, climatic balance housing and energy efficient choosing the residents' selection is always a goal for better housing reasons, but many important goals exist simultaneously in the housing selection project and at times these goals may conflict [2]. Geophysical, environmental, political, social, economic and regulatory factors interact to define the housing possibilities. This paper looks at AHP as a tool used in the housing sector to help in decision making.

Key words: Analytic hierarchy process · decision support system · mass housing planning · residents' selection

INTRODUCTION

Recent research in the application of integrated decision-support systems (DSS) in the housing sector utilizes the Analytic Hierarchy Process (AHP) [12]. Research conducted by the expert has focused on decision-support for stages of project planning, particularly as applied within the housing project. Dey et al. presented a mathematical model for controlling cost, time and quality of construction projects at the fortieth annual meeting of the Association for the. Advancement of Cost Engineering (AACE) Transactions held in Vancouver, British Columbia in 1996. The mathematical model presented in their paper utilizes goal programming for multiple criteria decisions that are inherited in project planning. Optimization goals within project planning can be vague due to the dynamics of forecasting strategic plans [2]. The innate nature of projects is such that forecasts must be connected with the realities of the operational situations and that usually necessitates change. Within the framework of goal programming, a hierarchical planning model is developed in which the relative effect of the change in one level of activity on other levels of activity is measured. In further research, Dey and others have applied this framework to different aspects of various projects, using AHP primarily for risk analysis. Main and Dai [6] apply the analytic hierarchy process broadly to project life cycle, further substantiating the value of AHP as a decision-support system for projects. AHP has been proposed as a multi-criteria decision technique in many industries, including technology for the assessment of decision-support systems [10]. This paper examines the significance of decisions in the Housing project, an overview of AHP and AHP as applied to the housing selection and mass housing planning. The discussion of AHP as applied to Housing project planning residences' selection contains an example of an application of AHP, which will serve as the model for discussion of AHP in the housing project planning and residents' selection.

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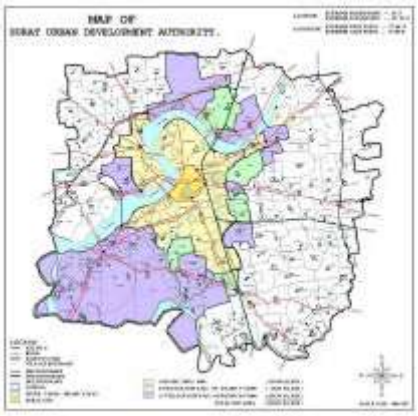
Significance of decisions in the residents' selection: The importance of decisions in the housing sector is reflected in the magnitude and nature of the housing industry. Worldwide, building material, contraction technology and skill manpower within urban and rural area to meet existing housing needs natural resource of building materials. The distances between the source of the building material and construction site. This is particularly true as more demand takes place in urban areas of the world [4]. Economies have become dependent upon the final products to meet the existing demand [6]. Housing project extended to all over country. They are capital-intensive projects with goals of long life expectancy. The environment in which strategic decisions regarding housing planning are made is greatly influenced by external factors [1]. These factors include government regulations, local resource materials, finance, ground condition and population growth [3]. Whereas housing is the basic need which considered the basic need of mankind [12].



Map. 1: Surat Urban area

An overview of AHP: Analytic Hierarchy Process is a decision-making technique developed in the 1970s by mathematician Thomas L. Saaty, now a professor at the University of Pittsburgh's Katz School [7]. AHP can be used in making decisions that are complex, unstructured and contain multiple attributes [8]. The decisions that are described by these criteria do not fit in a linear framework; they contain both physical and psychological elements [6]. AHP allows better, easier and more efficient identification of selection criteria, their weighting and analysis. It reduces drastically the decision cycle. AHP allows organization to minimize common pitfalls of decision making process, such as lack of focus, planning, participation or ownership which ultimately are costly distraction that can prevent teams from making the right choice. AHP provides a method to connect that that can be quantified and the subjective judgment of the decision maker in a way that can be measured. In applying AHP to benchmarking, Parotid describes the process in three broad steps: the description of a complex decision problem as a hierarchy, the prioritization procedure and the calculation of results. AHP is "a method of breaking down a complex, unstructured situation into its components parts; arranging these parts, or judgments on the relative importance of each variable; and synthesizing the judgments to determine which variables have the highest priority and should be acted upon to influence the outcome of the situation" [9]. A problem is put into a hierarchical structure with the level I reflecting the overall goal or focus of the decision [9].Level II contains factors or criteria for the decision; level III contains sub factors and level IV contains the decision options. The prioritization process is accomplished by assigning a number from a scale developed by Saaty to represent the importance of the criteria. A matrix with pair wise comparisons of these attributes provides the means for calculation. For more complex decisions, Saaty provides examples of Basic, FORTRAN and APL computer programs in his book published in 1990, Decision Making for Leaders. Expert Choice is software that has been developed by Saaty for AHP application that is used by the United States government and large corporations for complex decisions [7].

Study area: Surat is one of the fastest growing cities between Mumbai and Ahmedabad corridor. The city of Surat is situated on the bank of river Tapi having coastline of Arabian Sea on its west. Surat is the main center of business and commerce in South, at present Surat Municipal Corporation (SMC) area is about 334 sq. km which was 112 sq. km before the recent city limit extension before July 2006 as shown in map 1. In this study, Sachin Gujarat Public Housing (SGPH) and its surrounding private housing of Surat Urban Development Area (SUDA) are selected as the study area. SGPH is situated in the southern outskirts of SUDA.

Ahp in residents' selection in housing: The overall objective of residents' selection housing is the connection of the unit level planning, neighborhood guideline, financial, building materials and Vastu parameter considered to the completion site. Obviously, choosing the, affordable cost is always a goal for capital expenditure reasons, but many important goals exist simultaneously in the residents' selection in housing and

at times these goals may conflict [2]. Geophysical, environmental, political, social, economic and regulatory factors interact to define the housing scheme [2]. Poor residents' selection can be a costly mistake with long-term ramifications for a individual. An improperly selection can cause inefficient satisfaction that in crease mental stress. The analytic hierarchy process has been successfully applied for residences' selection, enabling the decision makers to connect the subjective and the objective factors involved in the multi-criteria decision. Geographic Information System (GIS) technology is integrated into the decision-support system and utilized to provide the Alternative location. In the model presented by expert, many possible locations were identified with attributes defined in a GIS database. In applying the AHP model as a problem solving technique, the ultimate hierarchy is the selection of a location. The intermediate level is composed of the broad goal categories (criteria) of location of project, infrastructure, amenity, road network planning, building material availability, environmental friendliness and climatic condition. Each of these factors has sub factors. Examples of the sub factors include minimizing environmental damage, ensuring accessibility, avoiding congestion, proper land use, nearer to work place using existing road network if possible, avoiding hazardous condition and flooding to area minimum [5]. The scale of relative importance for pair wise comparison as developed by Saaty is shown in Table 1 [9].

Table 1: The pair wise combination scale

Intensity	definition	explanation
1		Equal importance two activities contribute equally to the object
3		Moderate importance slightly favor one over another
5		Essential or strong importance strongly favors one over another
7		Demonstrated importances Dominance of the demonstrated in practice
9		Extreme importances Evidence favoring one over another of highest
Possible order of affirmation		
2, 4, 6, 8		Intermediate values when compromise is needed

Table 2: Comparison Matrix at Level II

Residents' selection	Unit level	neighbor-hood	Financial	Building material	Vastu	Weight
Unit level	1	5	1	4	5	2.152
Neighborhood	1/5	1	1/4	3	4	0.903
Financial	1	4	1	2	7	2.237
BuildingMaterial	1/4	1/3	1/2	1	1	0.530
Vastu	1/5	1/4	1/7	1	1	0.372

The judgment of the decision maker is then used to assign values from the pair wise combination scale to each main criterion for a level II analysis. A pair wise comparison matrix using a given example is then developed as shown in Table 2 [2]. In constructing the matrix, the question to be asked as each factor comparison is being made is "how much more strongly does this element (or activity) possess-or contribute to, dominate, influence, satisfy, or benefit- the property than does the element with which it is being compared?" [9]. the first element of the comparison is in the left column and the second element is found in the top row to the right of the first element's row position. A score is assigned indicating the importance of the first element in comparison to the second element. When comparing a factor to itself in the matrix, the relationship will always be one. Therefore, there will always be a diagonal of ones in the matrix. A reciprocal relationship exits for all comparisons.

Relative weights are calculated for each factor through a mathematical basis established by Saaty. The process involves "following a path from the top of the hierarchy to each alternative at the lowest level and multiplying the weights along each segment of the path"[9]. "The outcome of this aggregation is a normalized vector of the overall weights of the options" [9]. The matrix is then repeated in a more extensive format for a level III analysis, applying the weights calculated for the factors in the level II analysis to weights developed for each sub factor as calculated for each alternative route. In the bottom level of the hierarchy (level IV), an aggregate weight is calculated for each housing. The building are then ranked by overall weight, with the lowest weight indicating the least selected by people or moderately more important. The case study applying this methodology to residents' selection concluded with a route chosen as optimal that was actually longer than two of the other possibilities, but with less complexibility associated with other factors.

Analytic hierarchy process in housing planning: Mass housing is an important aspect of the basic need because of the correlation between social aspects with lively hood day to day life. Historically housing policy has been based on experience but current trends are toward a more organized, proactive methodology [2]. Government is utilizing data analysis and in-house studies to target areas of the different income group. This is a task because of the prevailing system. AHP provides a methodology for analysis, which, when applied to housing project failure potential, creates a "cost-effective, customized, flexible and logical design plan" [2]. The focus of the hierarchy is the probability of selection for housing. The level I

goal is to determine the probability of failure. The level II criteria include likelihood of external interference, construction or material or acts of God [2]. Following the procedure for applying the analytic hierarchy process, each factor has sub factors identified at level III. The level III sub torso includes, but is not limited, to internal or external. Pair wise comparisons are made between each level I criterion and then between each level II criterion to establish a risk factor for each project. Level IV is each housing segment represented in the analysis. The housing are then ranked according to likelihood for selection. At this point, the housing identified as most likely to have failure potential can be broken into segments of deferent part and the process repeated to further isolate the location most likely to. When dividing the housing into segments for further analysis, "the number of segments should be based upon the similarity of conditions from the point of view of planning probability, instead of arbitrarily dividing the housing into any equal segments". It is evident that this type of analysis that allows for comparisons made on a sequentially smaller area can be valuable in isolating areas most likely to, creating a safer planning program.

The planning of mass housing is a complex, extremely capital-intensive project with many decision variables. AHP has been integrated within a decision-support system, creating a framework for the planning phase of housing project. As a response to the limitations of the conventional approaches to project planning, researchers have developed a mathematical model for project planning as applied to a mass housing project. This model enables project management to "establish an adequate relationship between the essential design parameters technical requirements, construction schedules, investment planning and related expenditure and to create reference documents (time schedule, cost estimation and specification,) at the early feasibility states of the project" [2]. AHP is applied in this model to measure rank this value is then incorporated in the project breakdown structure. Typical components of planning project in the planning of housing include housing spreads, road network, infrastructure amenities, survey and field engineering, land acquisition and construction [2]. Each component is a work package, which is then broken down into factors and sub factors relative to that overall goal. The same methodology explained in the housing selection discussion is applied to each of the work packages, with the factors and sub factors being identified through the analyst's experience or a technique such as Spread Sheet Programming (SSP) [5]. In this way each society is then assigned a high, medium, or low total acceptability. Selection has been defined through a traditional matrix structure.

CONCLUSION

- The analytic hierarchy process, as developed by Thomas Saaty, has been successfully applied in recent research to cases of project planning, residents' selection, planning in the mass housing project.
- Researchers have integrated AHP with goal programming into a decision-support system for overall project and planning.
- The nature of project planning is dynamic and AHP allows for measuring the effect of change. AHP has been integrated into a decision-support system with geographic information system technology for residents' selection, creating a methodology for decision optimization in the existence of conflicting goals.
- Housing requirement has tradition been "hit or miss" or reactive due to the vastness of the requirement. AHP, as applied to mass housing project, offers a highly effective, proactive method of isolating areas of most likelihood for.
- There are two primary benefits for application of AHP in this research which would be applicable to any sector. AHP is a technique for the breaking down a complex problem with many factors by relating pairs of factors. In relating the factors, quantitative analysis and the subjective judgment of the decision makers can be connected.

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