A Decision Concept to Support House Hunting

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***Abstract*—House hunting, or the act of seeking for a place to live, is one of the most significant responsibilities for many families around the world. There are numerous criteria/factors that must be evaluated and investigated. These traits can be both statistically and qualitatively quantified and expressed. There is also a hierarchical link between the elements. Furthermore, objectively/quantitatively assessing qualitative characteristics is difficult, resulting in data inconsistency and, as a result, uncertainty. As a result, ambiguity must be dealt with using the necessary processes; otherwise, the decision to live in a particular property would be incorrect. To compare criteria, the Analytic Hierarchy Process (AHP) is employed, evidential reasoning is used to evaluate houses based on each criterion, and TOPSIS is used to rank house sites for selection. It was necessary to analyze qualitative and quantitative elements, as well as economic and social features of these residences, in order to arrive at the final order of houses, which was not an easy process. As a result, the authors developed a decision support model to aid decision makers in the management of activities related to finding a suitable dwelling. This study describes the development of a decision support system (DSS) capable of providing an overall judgment on the location of a house to live in while taking into account both qualitative and quantitative factors.**

Keywords*—*AHP; multiple criteria decision Making (MCDM); uncertainty; evidential reasoning

I. Introduction

Chittagong is a lovely town with a business district that looks out over the port. Because of its tranquil and secure environment, Chittagong attracts a large number of families. However, house seeking is a tedious activity in Chittagong and around the world. It's difficult to find the right neighborhood to reside in without first conducting extensive research into the city's many communities. For a home buyer or renter, selecting the most amazing house is a multi-step procedure. It necessitates the measurement and evaluation of a large number of criteria at the same time. Because several of these criteria are linked, they frequently collide, with one improvement usually resulting to a decrease in another [1]. Furthermore, because house features are quantifiable and qualitatively expressed, decision-makers must consider both quantitative and subjective data [2]. House hunting in Bangladesh is a terrible since various real estate businesses employ static ways to find houses in databases [1], such as the typical search methodology as shown in Fig. 1. This is a time-consuming procedure that yields no relevant results. As a result, potential homeowners may still miss out on their desired property.

In real life, MCDM issues are fairly common. One of the issues is house hunting. Many concepts have been proposed to address the home hunting dilemma but no model provides proper ranking or human level accuracy due to some limitation. Analytical Hierarchical Process technique can handle both quantitative and qualitative information [1, 2]. A multiple criteria decision model with a hierarchical structure is provided for the house-buying process, in which both quantitative and qualitative information is represented in a combined manner [3, 4]. After that, the AHP [5] approach is used to fully investigate the house hunting problem. As a result, the paper discusses the design, development, and implementation of a Decision Support System [6] that can accurately find a suitable house in a short amount of time at a low cost but this paper could not address the uncertainty.

Research [7] contains a lot of evidence. Using a belief structure to characterize an assessment as a distribution is advised for house seeking with 16 criteria and 5 alternatives. Four alternative evaluation grades were used to calculate the degree of belief: excellent, good, average, and bad. The ER approach was used to compute the cumulative degree of trust for a hierarchy's top level attribute based on its bottom level

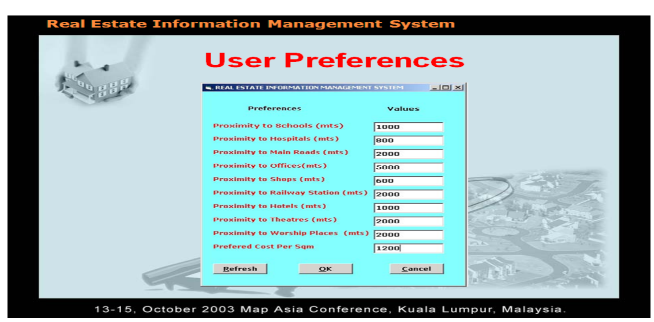

Fig. 1. Scenario in Bangladesh.

attribute. After that, the utility function was used to rank the various options. Many authors have solved various problems using AHP. The AHP technique was presented by Lakshmanan [8] for the condition ranking of reinforced concrete bridges. Rashidi et al. [9] developed a decision-making system for steel bridge asset management that meets acceptable safety, functionality, and sustainability criteria. Mahmoud et al. [10] demonstrated how to conduct a genuine bridge evaluation, which includes visual examination and data collection in order to provide an accurate estimate of the bridge's restoration and road network priority. As a result, a Bridge Overall Need Indicator was developed, which assigns a rating to bridges depending on their condition and priority for maintenance. For the selected bridges and their rehabilitation priority ranking, the Approach for Order Preference by Similarity to an Ideal Solution (TOPSIS) [11] technique is also used as a multi-criteria analysis tool. The Euclidian distances between each option form the ideal and anti-ideal alternative are determined when the ideal and anti-ideal alternatives have been found. Finally, the relative closeness (RC) of the bridges is shown, with the bridge with the lowest RC obtaining the highest repair priority.Paper [12] experiments with Temnothorax albipennis ant colonies In order to select the best one, compare and contrast huge and tiny colonies.The ant [13] colony house-hunting challenge has been approached from a distributed computing standpoint [14]. Where two different types of algorithms are shown.

There has never been a study that combined the AHP, TOPSIS, and evidential reasoning to develop a house priority ranking that has been shown to be more precise and accurate than previous methods. In this approach, a new concept for selecting outstanding houses is suggested. The goal hierarchy [15] structure is developed in three stages with the help of interactive groups [16]. Real estate professionals, economic specialists, and users make up four different types of decision makers. Each expert developed criteria based on their knowledge and experience. The Analytic Hierarchy Process (AHP) method is used to compute Saaty's scale criteria weights [17, 18].Depending on whether the criterion is qualitative or quantitative; it is assigned an interval rating. These ratings are also used to rate the houses within each category. Each group developed a set of common evaluations based on feedback from all of the participants. The evidential reasoning approach is used to determine the house assessments based on each criterion. The aggregated belief judgment matrix is used to determine the final house evaluations. Furthermore, the Technique for Order Preference by Similarity to an Ideal Solution (TOPSIS) [17] technique is utilized to rank the shortlisted houses based on a multi-criteria analysis. The Euclidian distances between each option form the ideal and anti-ideal alternative are determined when the ideal and anti-ideal alternatives have been found. Finally, the relative closeness (RC) is displayed, with the option with the lowest RC being chosen first. The proposed solution is based on a multi-criteria analysis, which would improve decision-making quality in the home site selection process.

The study is broken into five sections. Sections II, III and IV covers the theoretical basis of multi-criteria procedures like AHP, TOPSIS, and evidential reasoning, followed by a discussion of the suggested model. Section V states the proposed concept. In Section VI, the obtained results are provided, and throughout the discussion and the obtained results are compared to those of previous studies. This section also examines the new proposed model's advantages and disadvantages.

II. AHP for House Hunting

In Bangladesh and around the world, the home hunting problem (HHP) is a big concern [2]. It takes into account both qualitative and quantitative criteria, such as closeness to hospitals, major roads, educational institutions, shops, offices, recreation centers, and police precincts. Multiple criterion's decision-making (MCDM) is a technique for determining the "best" home for a customer by balancing a number of aspects. The majority of these factors are linked in some way. Furthermore, as one criterion improves, it is common for many others to improve as well. Using language traits, DMs can make subjective assessments more easily. However, merging these two sorts of indicators, one quantitative and the other linguistic, can be difficult, which could generate issues when evaluating solutions. As a result, any MCDA method must be capable of aggregating these two types of measures consistently and reliably, resulting in a ranking of all decision options [19]. We gave some of the house searchers the same list of criteria they used for the house hunting problem [2] and asked them to choose the factors they consider when purchasing a property. We found that 80% of house hunters failed to meet the following criteria: pleasant neighborhood, proximity to stores, proximity to bus and rail stations, proximity to recreation center, police precincts, property insurance, and population density [2]. Qualitative and quantitative parameters such as proximity to a main road, a hospital, an office, a school, and cost per square foot [1] impact house hunting.

The nine comparisons in Fig. 2 were combined into a matrix. We have a 9 by 9 matrix because we have 9(nine) comparisons. We just need to fill up the upper triangular matrix because the diagonal components of the matrix are always 1. The following two rules [1, 20] are used to fill the upper triangular matrix:

1. Utilize the true judgment value if the judgment value is on the left side of one.

2. Utilize the reciprocal value if the judgment value is on the right side of 1. utilize the reciprocal values of the top

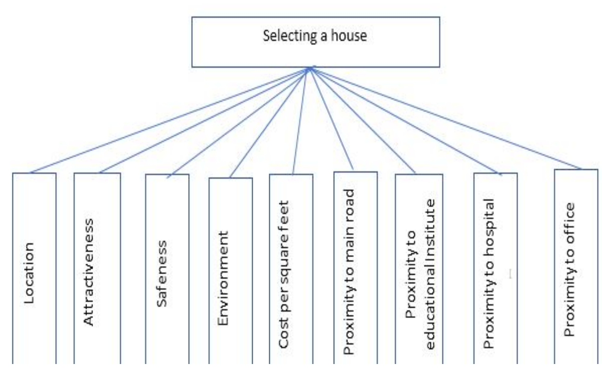

Fig. 2. Structure of Problem.

TABLE I. COMPARISON MATRIX OF CRITERIA

Criteria	Location	Attractiveness	Safeness	Environment	Prox. edu. org.	Prox. hospital	Prox. main roads	Prox. office	Cost per sq. ft
Location	1	2	1/3	1/4	1/5	1/6	4	1/5	1/2
Environment	4	3	1/4	1	4	1/3	7	1/3	1/2
Safeness	3	2	1	4	5	2	3	2	2
Prox. edu. org.	5	6	1/5	1/4	1	1/8	9	5	2
Prox. hospital	6	4	1/2	3	8	1	8	1/7	1/5
Prox. main roads	1/4	1/2	1/3	1/7	1/9	1/8	1	5	2
Prox. office	5	4	1/2	3	1/5	7	1/5	1	1/2
Cost per sq. ft	2	4	1/2	2	1/2	5	1/2	2	1

diagonal [1] to fill the lower triangular matrix. If aij is a row I and column j element in the matrix, the bottom diagonal is filled using eq. (1):

$$a_{ij} = \frac{1}{a_{ji}} \tag{1}$$

Users define their preferences for one criterion over another is illustrated in Table I, in the form of a comparison matrix.The comparison matrix's entries, which range from 1 to 9, represent the degree to which one criterion is preferred over another. For example, the 9 in the "Proximity to education institution" raw against "Proximity to main roads" column indicates that "Proximity to education institution" is preferred over "Proximity to main road".

A. Criteria Weights

It is important to normalize the prior comparison matrix in Table I, in order to evaluate and assign relative weights to each condition. Normalization is performed by dividing each table value by the total column value, as shown in eq. (2).

$$Z_{ij} = A_{ij} / \sum_{i=0}^{n} A_{ij} \tag{2}$$

The sum of all elements in a column in the normalized primary Eigen vector displayed in Table II is 1. Because it is normalized, the total of all elements in a column is 1.

The priority vector is then calculated by averaging each row in Table I and setting the overall priority vector to 1.

TABLE II. CRITERIA WEIGHTS

Location	0.05
Attractiveness	0.04
Safeness	0.17
Environment	0.10
Prox. edu. org.	0.15
Prox. hospital	0.16
Prox. mainroad	0.08
Prox. office	0.14
Cost per sq.ft	0.12

The priority vector represents the relative weights of the items we've compared. 5% for location, 4% for attractiveness, 17% for safety, 10% for the environment, 15% for proximity to education, 16% for proximity to hospital, 8% for proximity to main road, 14% for proximity to office, and 12% for cost per square foot. The most important selection criterion for a property buyer is safety, which is followed by the other elements. More than their rating is required in this scenario. The relative weight, in reality, is a ratio scale that can be divided among them. Customers value safety 3.4 (=17/5) times more than location and 2.1 (=17/8) times more than accessibility to a major route, for example.

III. EVIDENTIAL REASONING

The evidential reasoning algorithm lies at the heart of the ER approach. This method was created using an evaluation analysis model [1, 21] and the Dempster-Shafer theory's evidence combination rule [22, 23], which is well-suited to dealing with incomplete uncertainty [24]. The ER method models an assessment as a distribution using a belief framework. It differs from prior Multi Criteria Decision Making (MCDM) modeling systems in that it reaches a result using evidence-based reasoning [15]. This method has the advantage of being able to deal with the uncertainties that arise in MCDM situations when dealing with quantitative and qualitative data [1, 2].

A. Assessment

The ER algorithm has strategies for dealing with such ignorance, as will be demonstrated. It's also important to distribute the degree of confidence throughout evaluation classes for some quantitative input data. If the hospital is within 1 kilometer of the residence, it is considered great, average if it is within 1.5 kilometers, ordinary if it is within 2 kilometers, and horrible if it is within 3 kilometers. However, when a hospital is only 1.3 kilometers away, it can be both beneficial and dangerous. It is crucial, however, that we recognize the distinction between exceptional and regular belief. This phenomena can be calculated using the method provided below [1, 23].

$$\beta_{n,i} = \frac{h_{n+1} - h}{h_{n+1}, i - h_{n,i}}, \beta_{n+1,i} = 1 - \beta_{n,i} \text{ if } \quad h_{n,i} \leq h \leq h_{n+1,i} \tag{3}$$

As a result, equation (3) can be used to evaluate the distribution of degree of belief within 1.3 km of the hospital's position from the residence, obtaining the following results: (Excellent, 0.4), (Good, 0.6), (Average, 0), (Bad,0).

B. Weight Normalization

Determining the value of the traits is crucial since each characteristic serves a specific purpose in the decision-making process. At level , there are eight sub attributes in the "Facilities" category, including proximity to educational institutions, major roads, hospitals, shops, offices, bus and railway stations, police precincts, and recreation centers. When evaluating their parent characteristic "Facilities", it's critical to determine which of the eight features is the most important. This can be accomplished using a variety of weight normalization approaches, including Eigenvector, AHP, and Pairwise comparison [1, 24].

$$\omega_i = \frac{y_i}{\sum_{i=1}^{j} y_i}; i = 1 \ldots\ldots\ldots\ldots j \quad (4)$$

$$\sum_{i=1}^{L} \omega_i = 1 \quad (5)$$

Equation (4) is used to estimate the significance of an attribute (w_i). This has been designed by dividing the significance of an element (y_i) by the $\sum_{i=1}^{j} Y_i$ summation of significance of all the elements. Equation (5) is to see if the sum of the importance of all the qualities was one or if they were normalized.

C. Basic Probability Assignment

Not resembles to Dempster-Shafer [25] evidence theory finding degrees of belief in the attribute evaluation grades must be converted into fundamental probability masses using equation (6). The fundamental probability mass represents the precise belief provided to an attribute's n-th evaluation grade. It also demonstrates how strong the evidence is in support of the attribute's n-th evaluation grade(H_n) [23].

$$\begin{aligned} m_{n,i} =& m_i\left(H_n\right) = w_i \beta_{n,i}\left(a_l\right), \\ & n = 1, \ldots\ldots, N; i = 1.., L \end{aligned} \quad (6)$$

After the i-th attribute has been examined, the residual probability mass unassigned to any given grade can be calculated using the equation below.

$$\begin{aligned} m_{H,i} =& m_i(H) = 1 - \sum_{n=1}^{N} m_{n,i} = \\ & 1 - w \sum_{n=1}^{N} \beta_{n,i}\left(a_l\right), i = 1.., L \end{aligned} \quad (7)$$

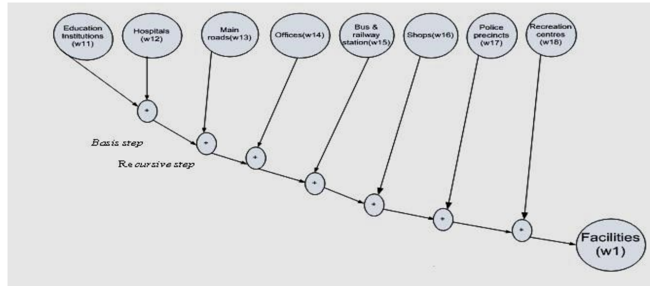

Fig. 3. Recursive Assessment.

D. Kernel of ER Approach

The ER approach calculates the cumulative degree of confidence at the top level attribute of a hierarchy using the hierarchy's bottom level features, also known as fundamental attributes. An excellent information synthesizing/aggregation process achieves this. A recursive ER algorithm is used to aggregate fundamental attributes, which can be stated as $A(S) = \{(H_n, \beta_n), n = 1, .., N\}$ evaluating the cumulative degree of confidence of the top level attribute in a hierarchy. In this recursive ER algorithm, all the basic attributes are aggregated recursively in the following manner as shown in Fig. 3.

$$M_1 = \begin{bmatrix} m_{11} & m_{21} & m_{31} & m_{41} & m_{H1} \\ m_{12} & m_{22} & m_{32} & m_{42} & m_{H2} \\ m_{13} & m_{23} & m_{33} & m_{43} & m_{H3} \\ m_{14} & m_{24} & m_{34} & m_{44} & m_{H4} \\ .... & .... & .... & .... & .... \\ .... & .... & .... & .... & .... \\ .... & .... & .... & .... & .... \\ m_{18} & m_{28} & m_{38} & m_{48} & m_{H8} \end{bmatrix}$$

From matrix M_1, it can be seen that each sub-attribute is associated with five basic probability assignment (bpa), where four first four bpa $(m_{11}, m_{21}, m_{31}, m_{41}$ are associated with four evaluation grades (H_1, H_2, H_3, H_4) and final bpa i.e. is showing the remaining probability mass unassigned to any individual grades after the assessments on sub-attribute have been considered. The aggregation is carried out in a recursive way. This aggregation can be achieved by using the following equation(8) , which will yield combined bpa (such as $m_{1I(2)}, ...m_{4I(2)}$) as shown in the first row of the second matrix [1, 23].

$$m_{1I(2)} = K_{I(2)}(m_{11}m_{12} + m_{H1}m_{12} + m_{H2}m_{11}) \quad (8)$$

Similarly $m_{2I(2)}, m_{3I(2)}, m_{4I(2)}$ can be calculated.

Where $K_{I(2)}$ is a normalization factor used to resolve the conflict and this can be calculated using the equation (9) [1, 23]..

$$K_{I(i+1)} = \left[1 - \sum_{n=1}^{N} \sum_{t=1 \frac{t}{\neq} n}^{N} m_{n,(i)} m_{t,i+1}\right], i = 1, \ldots . L - 1 \ldots . \quad (9)$$

Equation (9) represents the more generalized version of equation (7) [1, 23].

$$\{H_n\} : m_{n,(i+1)} = K_{I(i+1)}[m_{n,T(i)}m_{n,i+1} + m_{n,(i)}m_{H,i+1} + m_{H,T(i)}m_{n,i+1}] \quad (10)$$

$$m_{H,I(i)} = \overline{m_{H,I(i)}} + \widetilde{m}_{H,I(i)} n = 1, \ldots\ldots\ldots, ., N \quad (11)$$

$$\{H\} : \widetilde{m}_{H,l(i+1)} = K_{I(i+1)}[\widetilde{m}_{H,l(i)}\widetilde{m}_{H,i+1} + \widetilde{m}_{H,T(i)}\bar{m}_{H,i+1} + \bar{m}_{H,(i)}\widetilde{m}_{H,i+1}] \quad (12)$$

$$\{H\} : \bar{m}_{H,I(i+1)} = K_{I(i+1)} \left[\bar{m}_{H,I(i)}\bar{m}_{H,i+1}\right] \quad (13)$$

The combined degree of belief is calculated using equation 14 based on the final combined basic probability assignment, which in this case is "facilities".

$$M_2 = \begin{bmatrix} m_{1/(2)} & m_{2/(2)} & m_{3/(2)} & m_{4/(2)} & m_{HI/(2)} \\ m_{13} & m_{23} & m_{33} & m_{43} & m_{H3} \\ m_{14} & m_{24} & m_{34} & m_{44} & m_{H4} \\ m_{15} & m_{25} & m_{35} & m_{45} & m_{H5} \\ .... & .... & .... & .... & .... \\ .... & .... & .... & .... & .... \\ m_{18} & m_{28} & m_{38} & m_{48} & m_{H8} \end{bmatrix}$$

$$\{H_n\} : \beta_n = \frac{m_{n,I(L)}}{1 - \overline{m_{H,I(L)}}}, n = 1, \ldots\ldots..N \quad (14)$$

$$H : \beta_H = \frac{\widetilde{m}_{H,I(L)}}{1 - \overline{m_{H,I(L)}}}, \text{ Where } m_{n,I(1)} = m_{n,1}(n = 1, ..N) \quad (15)$$

β_n and β_H represent the belief degrees of the aggregated assessment, to which the general factor (such as "facilities") is assessed to the grade H_n and H, respectively. The combined assessment can be denoted by $S(y(a)) = \{(H_n, \beta_n(a_l)), n = 1......., N$ It has been proved that $\sum_{n=1}^{N} \beta_n + \beta_H = 1$ As shown in Table II, the recursive ER technique runs over each piece of evidence one by one. The belief decision matrix was created by combining all of your beliefs using equation (16) [2, 23].

$$\beta_j = \frac{\mu \times \left[\Pi_{k=1}^{L}\left(\left(\omega_k\beta_{jk} + 1 - \omega_k \sum_{j=1}^{N} \beta_{jk}\right)\right) - \Pi_{k=1}^{L}\left(1 - \omega_k \Sigma_{j=1}^{N} \beta_{jk}\right)\right]}{1 - \mu \times \left[\Pi_{k=1}^{L} 1 - \omega_k\right]} \quad (16)$$

IV. The TOPSIS Method

TOPSIS is a method for rating preferences based on how near they are to the ideal solution, not as A Belief Rule Base (BRB) [26, 27] it is a conceptual modeling structure that facilitates the capturing of ambiguous information TOPSIS is a helpful and practical non - linear decision-making method for real problems [11]. In accordance this theory, ideal alternative is the one that is closest to the positive ideal option rather than negative one [11]. The positive ideal choice increases benefits while decreasing costs, whereas the other one(negative) increases costs while decreasing benefits. Hence the positive ideal option contains all conceivable ideal criteria values, rest one contains all attainable worst criterion values [11]. Each criteria is expected to increase or decrease over time. If each criterion has a monotonic ascending (or falling) efficient mechanism, the positive ideal option with the best assessment criteria and the rest one with the lowest criteria values may be determined [28]. To find the distance between positive and negative ideal decision Euclidean distances is being used. Best order of possibilities is determined by comparing Euclidean distances.

V. The Proposed Decision Concept

Vagueness predominates in real-life decisions due to insecure, inaccessible, and ambiguous information such as fuzziness, imprecision, incompleteness, and ignorance [28]. Rather than being made by a single decision maker, the bulk of decisions are made by a group of decision makers. As a result, the focus of this research is on decision-making under uncertainty and the use of multiple decision-makers in groups to solve a belief multi-criteria decision-making problem. The decision concept was created to describe decision makers' judgments in ambiguous decision situations [29]. The decision concept was developed and is used to describe decision makers' judgments in unclear choice circumstances. Because of the aforementioned setting, the AHP-evidential reasoning-TOPSIS approach is employed to develop the choice concept for the group multi criteria decision making problem using 13 phases [29].

Phase 1: Addressing the issue and bringing together the required expertise and parties. Organizing them into groups and deciding on a study subject.

Phase 2: The second part involves locating and mapping old pedestrian bridges.

Phase 3: Establish a goal hierarchical system by establishing the core goal and then dividing up it into objectives, criterion, and choices at the bottom level.

Phase 4: Using the AHP approach, create a comparison matrix for every group.

Phase 5: The priority vector and highest eigenvalue of each matrices are obtained once each group has defined its criterion weights.

Phase 6: Using the consistency ratio to determine the reliability of comparison matrices.

Phase 7: Create a belief choice matrix for every group and assign weights to the decision-makers' groupings.

Phase 8: Create a belief choice matrix that includes all of your beliefs.

Phase 9: Normalize the group belief choice matrix once it has been aggregated.

Phase 10: Specify the A+ and A- characters, which represent positive and negative ideal alternatives.

Phase 11: Using the Euclidean distance, , calculate the distance(Ei+ and Ei-) between the existent options and the positive and negative ideal alternatives.

Phase 12: Use the following method to determine the degree of resemblance to the ideal alternative.

Phase 13: Prioritize the options using RCi.

VI. Results and Analysis

A numerical representation of the suggested decision notion is included in this section in Table V. The AHP method is used to calculate the criteria weights. The distance between each choice and the positive-ideal and negative-ideal alternatives is determined using the multi-criteria TOPSIS technique, which scores the options. Each criterion has a minimum and maximum value, allowing benefit and cost criteria to be distinguished. Houses are given a priority rating as a result of the proposed method. The ranking results are then presented to the final decision maker, who is now better equipped to make decisions concerning the next steps in the home selection process. We looked at the ER strategy and how to put it into practice in the previous section. As a result, we'll look at the results of applying the proposed idea to dwelling quality in Chittagong in this part. As shown in Fig. 1, house quality can be divided into two categories: objective and subjective qualities, with each attribute weighted.Positive and negative ideal alternatives are found form Table III.

As a result, the residential site with the shortest relative closeness receives the lowest score. Table III shows the priority ranking of housing locations with RC = 0.81 and 0.05, Devpahar is ranked first, whereas Jamal Khan is ranked last. These studies were compared to a proposed decision concept based on the AHP-evidential reasoning-TOPSIS methodology, in which collected data is run through the AHP, TOPSIS, and AHP-TOPSIS, and the results are compared to a proposed decision concept based on the AHP-evidential reasoning-TOPSIS methodology.The results are presented in the Table IV From the given outcomes, it is obvious that the combination of the two multi-criteria methods gain more precise ranking, but still not quite similar as obtained by the proposed approach. Table V shows belief determination matrix created using the alternate assessments of all groups.

$$(E - Excellent, G - Good, A - Average, B - Bad)$$

A^{+}=[{ E(0.4),G(0.0),A(0.3),B(0.1)}; {E(0.4),G(0.2),A(0.1),B(0.1)}; {E(0.3),G(0.2),A(0.3),B(0.1)};
{E(0.4),G(0.0),A(0.1),B(0.1)}; {E(0.3),G(0.2),A(0.3),B(0.1)}; {E(0.4),G(0.4),A(0.1),B(0.0)};
{E(0.4),G(0.2),A(0.3),B(0.1)}; {E(0.4),G(0.3),A(0.3),B(0.0)}; {E(0.4),G(0.1),A(0.3),B(0.1)};
{E(0.4),G(0.4),A(0.1),B(0.1)}; {E(0.4),G(0.2),A(0.1),B(0.1)}; {E(0.4),G(0.1),A(0.3),B(0.1)};
{E(0.4),G(0.4),A(0.0),B(0.0)}; {E(0.3),G(0.2),A(0.3),B(0.1)}; {E(0.4),G(0.2),A(0.1),B(0.1)}]

A^{-}=[{ E(0.4),G(0.1),A(0.3),B(0.1)}; {E(0.4),G(0.1),A(0.1),B(0.3)}; {E(0.3),G(0.2),A(0.3),B(0.2)};
{E(0.4),G(0.0),A(0.2),B(0.1)}; {E(0.3),G(0.2),A(0.3),B(0.0)}; {E(0.4),G(0.4),A(0.0),B(0.0)};
{E(0.4),G(0.1),A(0.3),B(0.1)}; {E(0.4),G(0.3),A(0.0),B(0.0)}; {E(0.4),G(0.0),A(0.3),B(0.1)};
{E(0.3),G(0.4),A(0.1),B(0.1)}; {E(0.4),G(0.2),A(0.0),B(0.1)}; {E(0.3),G(0.3),A(0.3),B(0.1)};
{E(0.3),G(0.1),A(0.3),B(0.1)}; {E(0.5),G(0.1),A(0.3),B(0.0)}; {E(0.3),G(0.2),A(0.3),B(0.1)}],

TABLE III. The Distances between Alternatives and the Ideal and Anti-Ideal, as well as Proximity Coefficients

Alternative	khulsi	Devpahar	Jamal Khan	Suganda	Chandgoan
Ei^{+}	0.15	0.11	0.4	0.30	0.40
Ei^{-}	0.10	0.05	0.5	0.40	0.45
Relative Closeness(RC)	0.72	0.81	0.05	0.20	0.10
Ranking	2	1	5	3	4

TABLE IV. The Proposed Concept is Contrasted to the Findings of Other Studies

Methodology	Ranking
AHP	Khulsi $>$ Jamal khan$>$ Suganda $>$ DevPahar$>$Chandgoan
TOPSIS	Khulsi$>$ DevPahar$>$Suganda $>$ Jamal khan $>$Chandgoan
AHP + TOPSIS	Khulsi $>$ Suganda $>$Jamal khan $>$DevPahar $>$Chandgoan
Evedential Reasoning	Khulsi $>$ Jamal khan $>$Suganda $>$Dev Pahar $>$Chandgoan
AHP + Evidential Reasoning TOPSIS	DevPahar$>$Khulsi$>$Suganda$>$Chandgoan$>$Jamal Khan

TABLE V. A Belief Determination Matrix was Created using the Alternate Assessments of All Groups

Alt	khulsi	Devpahar	Jamal Khan	Suganda	Chandgoan
Location	E(0.4), G(0.2), A(0.3), B(0.1)	E(0.8), G(0.2), A(0.8), B(0.2)	E(0.4), G(0.4), A(0.1), B(0.1)	E(0.4), G(0.2), A(0.8), B(0.1)	E(0.4), G(0.8), A(0.8), B(0.0)
Attract iveness	E(0.5), G(0.4), A(0.0), B(0.1)	E(0.4), G(0.2), A(0.8), B(0.1)	E(0.4), G(0.4), A(0.1), B(0.1)	E(0.4), G(0.2), A(0.8), B(0.1)	E(0.4), G(0.8), A(0.8), B(0.0)
Safety	E(0.4), G(0.4), A(0.1), B(0.1)	E(0.8), G(0.2), A(0.8), B(0.1)	E(0.4), G(0.4), A(0.1), B(0.1)	E(0.8), G(0.2), A(0.8), B(0.1)	E(0.4), G(0.8), A(0.8), B(0.0)
Envir onment	E(0.4), G(0.5), A(0.0), B(0.1)	E(0.2), G(0.2), A(0.8), B(0.1)	E(0.4), G(0.4), A(0.1), B(0.1)	E(0.5), G(0.2), A(0.8), B(0.0)	E(0.4), G(0.8), A(0.8), B(0.0)
Nice neigh borhood	E(0.4), G(0.2), A(0.8), B(0.1)	E(0.4), G(0.2), A(0.8), B(0.0)	E(0.4), G(0.8), A(0.1), B(0.1)	E(0.4), G(0.2), A(0.8), B(0.0)	E(0.4), G(0.8), A(0.8), B(0.0)
Prox. to edu org	E(0.4), G(0.8), A(0.8), B(0.0)	E(0.4), G(0.2), A(0.8), B(0.1)	E(0.4), G(0.2), A(0.1), B(0.1)	E(0.4), G(0.2), A(0.8), B(0.1)	E(0.8), G(0.8), A(0.8), B(0.1)
Prox. to hospital	E(0.4), G(0.2), A(0.8), B(0.1)	E(0.2), G(0.2), A(0.8), B(0.1)	E(0.8), G(0.4), A(0.1), B(0.1)	E(0.4), G(0.2), A(0.8), B(0.0)	E(0.4), G(0.2), A(0.8), B(0.0)
Prox. to shops	E(0.4), G(0.1), A(0.8), B(0.1)	E(0.8), G(0.2), A(0.8), B(0.1)	E(0.4), G(0.4), A(0.1), B(0.1)	E(0.4), G(0.0), A(0.8), B(0.1)	E(0.4), G(0.8), A(0.8), B(0.0)
Prox. to office	E(0.4), G(0.2), A(0.8), B(0.1)	E(0.5), G(0.2), A(0.8), B(0.0)	E(0.8), G(0.4), A(0.1), B(0.1)	E(0.4), G(0.2), A(0.8), B(0.1)	E(0.4), G(0.8), A(0.8), B(0.0)
Prox. to bus and rail station	E(0.4), G(0.1), A(0.8), B(0.1)	E(0.4), G(0.2), A(0.8), B(0.1)	E(0.4), G(0.4), A(0.1), B(0.0)	E(0.1), G(0.2), A(0.8), B(0.1)	E(0.8), G(0.8), A(0.8), B(0.1)
Prox. to recreation centers	E(0.4), G(0.0), A(0.8), B(0.1)	E(0.4), G(0.2), A(0.8), B(0.1)	E(0.4), G(0.4), A(0.0), B(0.1)	E(0.8), G(0.2), A(0.8), B(0.1)	E(0.4), G(0.8), A(0.8), B(0.1)
Prox. to main road	E(0.4), G(0.0), A(0.8), B(0.1)	E(0.4), G(0.1), A(0.8), B(0.1)	E(0.4), G(0.0), A(0.1), B(0.1)	E(0.8), G(0.2), A(0.8), B(0.1)	E(0.8), G(0.8), A(0.8), B(0.1)
Police precincts	E(0.4), G(0.0), A(0.8), B(0.1)	E(0.4), G(0.2), A(0.2), B(0.1)	E(0.4), G(0.0), A(0.1), B(0.1)	E(0.4), G(0.2), A(0.8), B(0.1)	E(0.4), G(0.8), A(0.8), B(0.0)
Property insurance	E(0.4), G(0.2), A(0.8), B(0.1)	E(0.4), G(0.2), A(0.1), B(0.1)	E(0.4), G(0.4), A(0.1), B(0.1)	E(0.1), G(0.2), A(0.8), B(0.1)	E(0.8), G(0.8), A(0.8), B(0.1)
Population density	E(0.4), G(0.1), A(0.8), B(0.1)	E(0.4), G(0.2), A(0.8), B(0.1)	E(0.4), G(0.2), A(0.1), B(0.1)	E(0.4), G(0.1), A(0.8), B(0.1)	E(0.4), G(0.8), A(0.8), B(0.0)
Cost per sq. ft	E(0.4), G(0.1), A(0.8), B(0.1)	E(0.8), G(0.2), A(0.8), B(0.1)	E(0.4), G(0.4), A(0.1), B(0.1)	E(0.4), G(0.2), A(0.2), B(0.1)	E(0.8), G(0.8), A(0.8), B(0.1)

VII. Conclusion

The AHP-evidential reasoning-TOPSIS approach was used to handle multiple criteria house hunting challenges with unclear, incomplete, imprecise, and/or missing information. It is fair to argue that our proposed notion is a mathematically accurate technique for measuring housing quality since it uses a belief structure to characterize a judgment as a distribution. In several aspects, this technique varies from previous Multi Criteria Decision Making systems. As a result, because the attribute can be ordered or numbered at random, the AHP-evidential reasoning-TOPSIS technique can accommodate new attributes without having to redo the previous assessment. As a result, the order in which the essential qualities are collected has no bearing on the final findings. In contrast to Saaty's AHP technique, any number of additional homes can be analyzed without triggering a "rank reversal problem". The proposed decision paradigm's merits include the correctness and assurance of the achieved outcomes. Using a mix of multi-criteria approaches, more specific findings can be determined. The concept is simple to put into practice and may be applied to any decision-making problem.

VIII. Future Works

In a future study an expert system [30, 31] will be implemented into the suggested decision concept to reduce human involvement because stakeholders and experts must be involved throughout the process.

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