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Applying a Fuzzy Analytic Hierarchy Process to Demand Considerations of Households Opting for Mortgage Loans

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Abstract

The need for high economic development across the entire globe and Sub-Saharan Africa in particular has led to the awareness of the need to increase the housing base across the continent. The astronomical increase in population and urbanisation and its associated problems of accommodation call for the need to provide good housing for the people of Ghana; the provision of which could depends largely on the availability of mortgage facilities. However, obtaining the right mortgage is as crucial as obtaining the right home, yet buyers seemingly do not invest as much time and effort in a mortgage search as in house searches. It is against this backdrop that this study investigates factors considered by households before acquiring mortgage loans. A questionnaire was administered within the Accra metropolis, the area of Ghana with the most mortgage loan providers. We employed the fuzzy analytic hierarchy process (FAHP) to analyze the thought processes of households when making their decisions on acquiring a mortgage loan. The results indicated that factors considered by households when opting for a mortgage loan, ordered based on their degree of importance, were "Employment", "Housing Market Conditions", "Personal Factors", "Economic Factors", "Mortgage Lender Policy", "Housing Alternatives", "Knowledge", and "Social Factors". The weights of the first four factors were as high as 70.99% (Buckley's method) and 69.70% (Chang's method). These four items, have the most impact on household demand considerations when opting for a mortgage loan. If these factors are significantly improved, then, they can have a positive microeconomic impact on actual households demand for mortgage loans, in turn making the mortgage market a lucrative business.

Keywords: Mortgage loan, Fuzzy analytical hierarchy process, Households, Weight calculation.

Contents

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1. Introduction

Today, the demand for mortgage across the entire globe is on the ascendancy. Perhaps, this is largely informed by the high growth of population and its accompanying developments. As economies develop, it appears that, the provision of housing finance is moving away from extensive reliance on special circuits towards integration of housing finance into broader financial markets. Also, as populations continue to grow and urbanization accelerates, the necessity of providing adequate housing also becomes crucial.

A recent publication by Housing Finance International (HFI) shows that, Ghana is facing housing shortage which has worsened due to rapid population growth and increasing urbanisation; Ghana Real Estate Developers Association (GREDA), and Ghana Statistical Services (GSS) have also revealed that the housing deficit in Ghana as at 2009 stands at one million (1,000,000) housing units (Contributor, 2009). This phenomenon of housing shortages in Ghana to a large extent could be reduced if not eliminated through the availability of mortgage loans.

The challenge confronting city dwellers in terms of accommodation is enormous. Most residents of cities and large towns in Ghana encounter serious accommodation problems as they desperately look for decent and reasonably priced houses to rent. According to Coomson (2006), home ownership remains the key priority of most Ghanaians. However due to limited sources of mortgages, this priority has remained a dream for a significant proportion of the population. The benefits of housing cannot be underestimated. Housing provides shelter for individuals and corporate organisations, creating conducive environments for both the individual and corporate bodies to carry on their activities. In addition, the basic needs theory provides that, housing, like food and water, is a basic need and a necessity for the existence of man; the need for individual families to acquire their own private accommodation which they can call home, has become crucial. A nation's labour force is enhanced and further developed if it has a safe, decent and affordable means of accommodation. In the belief that 'adequate housing' is a basic human need, the United Nations General Assembly (UNGA) unanimously adopted a resolution proclaiming 1987 the International Year of Shelter for the Homeless (Tshipinare, 1987).

One of the major means of raising funds to finance the purchase of houses in many parts of the world is through the use of a mortgage. Apart from using the mortgage instrument to raise funds for acquiring residential properties, it is also widely used as a means of raising capital for business purposes. In the United Kingdom, for instance, about 95% of all business, responsible for nearly one third of all employments, rely on the mortgage as a method of raising finance to finance their operations (Gyamfi-Yeboah and Boamah, 2003). The unique feature of housing finance and its relative long- term investment horizon requires large amount of long term finance (Gyamfi-Yeboah and Boamah, 2003). The main aim of housing finance system is to provide funds to the producers and purchasers of housing of both rental and owner-occupied homes. This simple arrangement has spawned a broad array of institutional arrangements, ranging from contractual savings scheme to depository institutions specializing in mortgage finance, to the issuance, sale and trading of mortgage securities on the securities market. All these arrangements also help in channeling money from peoples who have excess funds to borrowers who are in need.

According to Smith (1996), the conventional approach takes a long time, often between five and fifteen years, for participants in the informal sector to complete the dwelling, which can massively increase construction costs. Equally important, funds that could effectively be used for other income-generating ventures are tied up in the property causing business to thrive or operate on meagre funds and thereby creating a lot of dead capital. This approach is seen as expensive and ineffective (Asare and Whitehead, 2006), causing the housing deficit gap to be widened.

After independence, the government's commitment to increase the housing stock in Ghana necessitated the establishment of institutions like Bank of Housing and Construction (now defunct) and the State Housing Company. Failure for these institutions to live up to expectation lead to the supply of housing through the incremental and the conventional approach where people use sweat equity, barter arrangements and remittances from abroad to build their houses (Erguden, 2002). To fill this gap, the government enacted the Home Mortgage Finance Law 1993, "PNDCL 329", which lead to the establishment of the Home Finance Company now HFC Bank Ghana Limited. The objective of this company was to provide the service of mortgage and also to raise funds for mortgage finance. Even though HFC was particularly established to facilitate the development of the mortgage sector, the recent introduction of the universal banking license by the Central Bank has removed or blurred the boundary and thereby has allowed a number of banks (i.e. merchant and investment banks) and other private individual firms to enter into the sector. In view of this, other banks are now offering mortgage loans within the banking industry whiles HFC has ceased it functionality in this sector. Residential property makes up a significant component of the stock of property in Ghana but the irony of the matter is that Ghana still faces housing shortage which has worsened in recent times due to rapid population growth and increasing urbanisation. Notwithstanding the recent improvement in urban housing development activities by the both the government and individuals, increasing overcrowding, declining quality and access to services has characterise much of housing stock in the country. The most common method of residential building in Ghana has been the incremental building, where owners become self-developers and rely on small crafts and trades to build their own units. This paper, however, seeks to investigate, factors considered before households decide to opt for a mortgage loan in Ghana using a Fuzzy Analytical Hierarchy Process (FAHP). By employing the FAHP we obtain the weights of the most important factors considered in the decision process that leads to households opting for a mortgage loan.

2. Literature Review

2.1. Defining Mortgage

The term is defined in Oxford Advance Learners Dictionary as a legal agreement by which a bank or similar organisation lends money to an individual to buy a property (house) and after repayment is made over a specified period of time; the sum of total payment includes the sum borrowed and interest.

"Mortgage" is nothing more than the name given to a particular type of loan; in this case, a real estate loan (McDonald and Thornton, 2008). However, the word mortgage alone, in everyday usage, most often means mortgage

loan. A home buyer or builder can obtain financing (a loan) either to purchase or secure against the property from a financial institution, such as a bank, either directly or indirectly through intermediaries. Characteristics of mortgage loans such as the size of the loan, maturity of the loan, interest rate, method of paying off the loan etc. largely depends on the household and the individual and therefore varies considerably.

In a set of theoretical papers based on standard microeconomic theory, the mortgage decision problem facing borrowers was initially modelled based on different assumptions (e.g., (Statman, 1982; Brueckner, 1986; Alm and Follain, 1987; Brueckner and Follain, 1988)). Results from these studies showed that the optimal choice should depend on, for instance, income stream, age, inflation and the mortgage rate spread. Campbell and Cocco (2003) further developed this theoretical line in a much cited article where they described optimal consumption and mortgage choice through a life-cycle model showing that borrowers with rather small mortgages, stable income, low default costs and high probability of moving in the near future should choose Adjustable Rate Mortgages (ARMs) over Fixed Rate Mortgages (FRMS).

2.2. Analytic Hierarchy Process and Fuzzy Analytic Hierarchy Process

The analytical hierarchy process (AHP) was developed by Saaty in 1971 (Saaty, 1980). This technique is primarily applied to decision problems in uncertain situations with multiple assessment criteria. The function of AHP is to systemize complex and unstructured problems, which it resolves gradually from the high to lower levels. Through quantitative judgment, AHP simplifies and improves earlier decision-making processes that relied on intuition to obtain the weights of each indicator and provide sufficient information for decision makers. Items with greater weights have higher priority. Using AHP to perform problem analysis can reduce the risk of mistakes in decision making (Chen *et al.*, 2012). However, AHP use cannot overcome the subjectivity, inaccuracy, and fuzziness produced when making decisions.

However, introducing fuzzy set theory and fuzzy operation to AHP can ameliorate these failures.
Fuzzy set theory was first presented by Zadeh in 1965 (Zadeh, 1965); it emphasizes the fuzziness of human thinking, reasoning, and cognition of surroundings. A number of conventional quantitative analysis methods cannot analyze such things efficiently. The concept of fuzzy logic must be used to describe actual things and to compensate for the failings of traditional theory sets that use only binary logic to describe things. Fuzzy logic uses the concept of membership function to describe things in a manner similar to common human language. Furthermore, fuzzy logic can analyze ambiguity and vagueness.
The fuzzy set can be defined as follows:

$$\tilde{A} = \{(x, \quad \mu_{\tilde{A}}(x)) \text{I } x \in U\} \tag{1}$$

where $\tilde{A}$ is a fuzzy set. $\mu_{\tilde{A}}(x)$ called the membership function. U is the universe of discourse.
$\mu_{\tilde{A}}(x)$ ranges between 0 and 1. This is called the degree of membership. The fuzzy set can better describe the characteristics of things compared to conventional binary logic. In conventional crisp sets, the value of the membership function can only be 0 or 1. Equation 2 expresses its membership function.

Equations 3 to 6 show the rules of operation for the triangular fuzzy number. The defuzzification operation should be performed according to the three criteria of rationality, ease of computation, and continuity to identify an appropriate point to represent the fuzzy number. Commonly used defuzzification methods include the mean of maximum method, the center of gravity method, and the center of area method (Li and Huang, 2008).

$$\mu_{\tilde{A}}(x) = \begin{cases} \frac{x-c}{a-c}, c \leq x \leq a \\ \frac{x-c}{a-c}, a \leq x \leq b \\ 0, otherwise \end{cases} \tag{2}$$

$$A' \oplus B' = (a_1 + a_2, b_1 + b_2, c_1 + c_2) \tag{3}$$

$$A' \ominus B' = (a_1 - a_2, b_1 - b_2, c_1 - c_2) \tag{4}$$

$$A' \otimes B' = (a_1 \times a_2, b_1 \times b_2, c_1 \times c_2) \tag{5}$$

$$A' \div B' = (a_1 \div a_2, b_1 \div b_2, c_1 \div c_2) \tag{6}$$

2.3. Empirical Review

Home purchase represents a major financial commitment for the homebuyer. For the majority, the finance required is borrowed from a lending institution (Duffy and Roche, 2005). Several writers have extensively written on the subject of wealth acquisition being a factor why households buy mortgage. Campbell and Cocco (2007) as example wrote in their paper, how houses prices affect consumption – evidence from micro data, that housing is the dominant component of wealth for the typical household in the United States or the United Kingdom; and in fact, housing wealth is particularly important for middle-class households. Similarly, Guiso *et al.* (2002) reported that real estate accounted for 35% of aggregate household wealth in the UK in the mid 1990's. Tracy and Schneider (2001), for example, showed that it accounts for almost two-thirds of the wealth of the median US household.

Rybár and Zemcik (2008) conducted a survey on ARM or FRM: Which Mortgage Contract Is Better for Czech Households? By using a non-random sample of 3000 households. The survey attempted to find out the welfare effects on FR and AR mortgage contract on Czech Households by calibrating and solving a life-cycle model used for this purpose by Campbell and Cocco (2003). They identified and developed models for variable such as household income, preferences, inflation, exchange rates, house prices, taxation and mortgage contracts to be the key factors that affected the choice between ARM and FRM, similar to what was found in Campbell and Cocco (2003).

Popplewell (2000) indicated that the reasons why a person might wish to raise funds for putting up the deeds of a property as security for a loan can broadly be divided into three. However, there are different requirements within these three broad segments. According to him the reasons may include whether to buy a house for the first time, to improve an existing one or buying additional houses for rental purposes (income generation).

Popplewell (2000) explained that, fist-time house buyers have several advantages over existing buyers to sellers. However, the existing buyers' credit history (credit worthiness) will be known to the seller. He said the risk that the

first time buyer may engage in moral hazards is minimal; they may also become the life time mortgage clients. In relation, first-time buyers may be better advised to borrow as much as possible on mortgage because of its long life span, rather than putting their own money into property.

Thirdly, Popplewell (2000) further explained that many people from time to time seek to improve or extend their property and because the rate of interest charged by a mortgage lender is generally lower than other forms of borrowing, the house owner will, more often than not, look to raise funds by way of mortgage. Usually, the formalities required in this category of lending are relatively simple in that, the lender will not necessarily need to carry out credit risk checks.

Asare and Whitehead (2006) further indicated that low incomes and the problems in determining credit history have been argued to be relevant challenges as far as mortgage loans are concerned in developing economies. Given the level of incomes in some developing countries like Ghana, lenders are reluctant to grant loans affordable to customers, and borrowers are not prepared to accept the terms (with high rates) proposed by lenders. For example, Karley (2002) emphasized the point that about 90% of all customers of a bank in Accra withdraw almost all their salary by the next pay day and for that matter make credit worthiness assessment by banks difficult. This suggests that since nothing or relatively small amounts are left in the accounts, all things being equal, nothing or relatively insufficient amounts will be left for the monthly mortgage repayment.

Quite a number of researchers have focused on the area of mortgage affordability with different definitions and measurement variables. Affordability is defined as the ability to purchase a dwelling of the appropriate size and minimum physical and sanitary standards and still have sufficient income to enjoy at least the minimum consumption of other essential goods and services (Hegedüs and Struyk, 2005). Gan and Hill (2009), showed that the concept of mortgage affordability can be thought of in at least three different ways. They drew distinction between the concepts of purchase affordability, repayment affordability and income affordability. According to them, Purchase affordability considers whether a household is able to borrow enough funds to purchase a house; repayment affordability considers the burden imposed on a household of repaying the mortgage whilst income affordability simply measures the ratio of house prices to income. Trimbath and Montoya (2002) described affordability as a public policy target that moves in three-dimensional space measured by three variables, thus, home prices, household income and mortgage interest rates. The concept is also frequently interpreted as the relationship between household income and housing expenditure; housing is affordable if expenditure relative to income is reasonable or moderate (Kutty, 2005).

In an attempt to safeguard investors' investment in businesses, lenders in contemporary business ensure that, borrowers meet certain strict basic requirements; where borrowers are unable to satisfy, they are rejected. These controls help lenders to prevent adverse selection (Saunders and Cornett, 2008). These basic requirements are categorized into five Cs – Condition, Character, Capacity, Capital, and Collateral (Karley, 2002). This litmus test is applied to the potential borrower to assess the ability of the borrower to honour his or her part of the contract (Asare and Whitehead, 2006; Saunders and Cornett, 2008).

Indisputably, the most important variable affecting preparedness to supply, or make funds available to borrowers as mortgage loans and its pricing is inflation and its associated currency depreciation risk (Asare and Whitehead, 2006). According to them, the problems are said to be two-fold - anticipated inflation increases money interest rates and therefore nominal payments and generates a front loading payment problem in compensating for the loss in purchasing power of the income over time. The possibility of unanticipated inflation increases the real interest rate that both savers and lenders require increasing the real cost of mortgages.

Inflation in most developing economies has led to loss of purchasing power both in absolute terms and especially relative to the foreign currency like the dollar, and as a result, the use of the dollar as the standard pricing unit of account for some product including housing. Levina and Zamulin (2002) explained "...the firm's decision to denominate prices in dollars is a case of price stickiness. At the times of high inflation, quoting prices in the domestic currency would require frequent price adjustments. If price adjustment is costly due to some menu costs, sellers can prefer to denominate prices for their products in a stable foreign currency, which allows keeping prices unchanged for a much longer period".

The dollarization phenomenon, in the context of housing, allows the domestic inflation element to be taken out of the interest rate. The practice as noted by Levina and Zamulin (2002) does not require any actual use of that currency and in most cases transactions are carried out in the domestic currency, while the unit of account is in foreign currency.

The choice of mortgage has been described as a complicated one (Barr *et al*., 2008) and as one of the most complex transactions ever undertaken by the majority of consumers (Woodward, 2003). The fact that individuals purchase mortgages infrequently (Essene and Apgar, 2007) and often negotiate them at the same time that they are undergoing a major life transition also adds to the complexity (Campbell, 2013). Scholars have also found that mortgagees are less than optimally knowledgeable about the possible future consequences of their choice. Even the most financially sophisticated borrowers often find it difficult to shop effectively for mortgages (Essene and Apgar, 2007).

Moreover, researchers have found evidence that many consumers who enter into complex financial contracts, such as mortgages, are financially illiterate (Lusardi, 2008a; 2008b). Individuals frequently fail to understand the terms and conditions of consumer loans and mortgages, and those with lower levels of financial literacy are more likely to have a costly mortgage (Moore, 2003). This evidence is also in line with findings by Bucks and Pence (2008), who found that borrowers experiencing large payment changes if interest rates rose were comparatively more likely to report not knowing their contract terms.

It is imperative to note that there are rudiments necessary for a successful mortgage market. Gyamfi-Yeboah and Boamah (2003) identified stable macroeconomic environment-that is a low inflation and interest rates as well as a stable currency to be inclusive. In addition to a sound macroeconomic environment, they also identified liquidity as most crucial factor for a vibrant mortgage market. To them liquidity is crucial because originators would need to

replenish funds to meet the demands for funds from other households (borrowers). Campbell and Cocco (2007) also said lack of liquidity would mean that lenders would have to wait for the full life of the loan which could in some cases range between 20 to 30 years before funds invested can be recovered from borrowers. This will cause a serious mismatch between the assets and liabilities (i.e. borrowing short and lending long) of the financial institutions, and can make lending more risky to the originators, especially in periods of interest rate fluctuations. It has been proven in most countries that secondary MM provides the level of liquidity required for a vibrant MM. In this market, originators are able to sell outstanding mortgage debts to other institutions that are willing to hold the debts for its life span. The successes chalked in the United States and some parts of Europe in this field attest to this fact (Gyamfi-Yeboah and Boamah, 2003), and it justifies the need for a secondary MM.

3. Research Method

3.1. Questionnaire Design and Survey

Keeney (1999) conducted an important study on customer value and found that the most direct method for understanding the value acknowledged by customers was to ask them. However, different consumers have different opinions on value. Value-focused thinking can be used to analyze and understand the correlation between these values. This method involves three steps.

The first step is developing a series of values acknowledged by customers. The second step is using generalized types to express each value. The third step is to organize the acknowledged value and indicate their relationship. Based on that study, we developed an assessment model for factors considered before households opt for mortgage loans.

We conducted a literature review and interviewed six experts (mortgage advisors and property developers) to confirm the division of the assessment hierarchical structure for households decision criteria's when opting for a mortgage into selection factors of 3 levels, 8 aspects, and then 28 indicators (Fig. 1). The first level is the mortgage decision selection assessment. The second level is the assessment aspects, personal factors, social factors, economic factors, employment, housing market conditions, mortgage lender policy and knowledge. The third level is the assessment indicators. These levels contain a total of 28 items. The questionnaires were administered to 500 mortgage owners in the Accra metropolis.

Below is the diagrammatic representation of the 8 key indicator variables and the 28 evaluation indicators in the Index (Fig. 1).

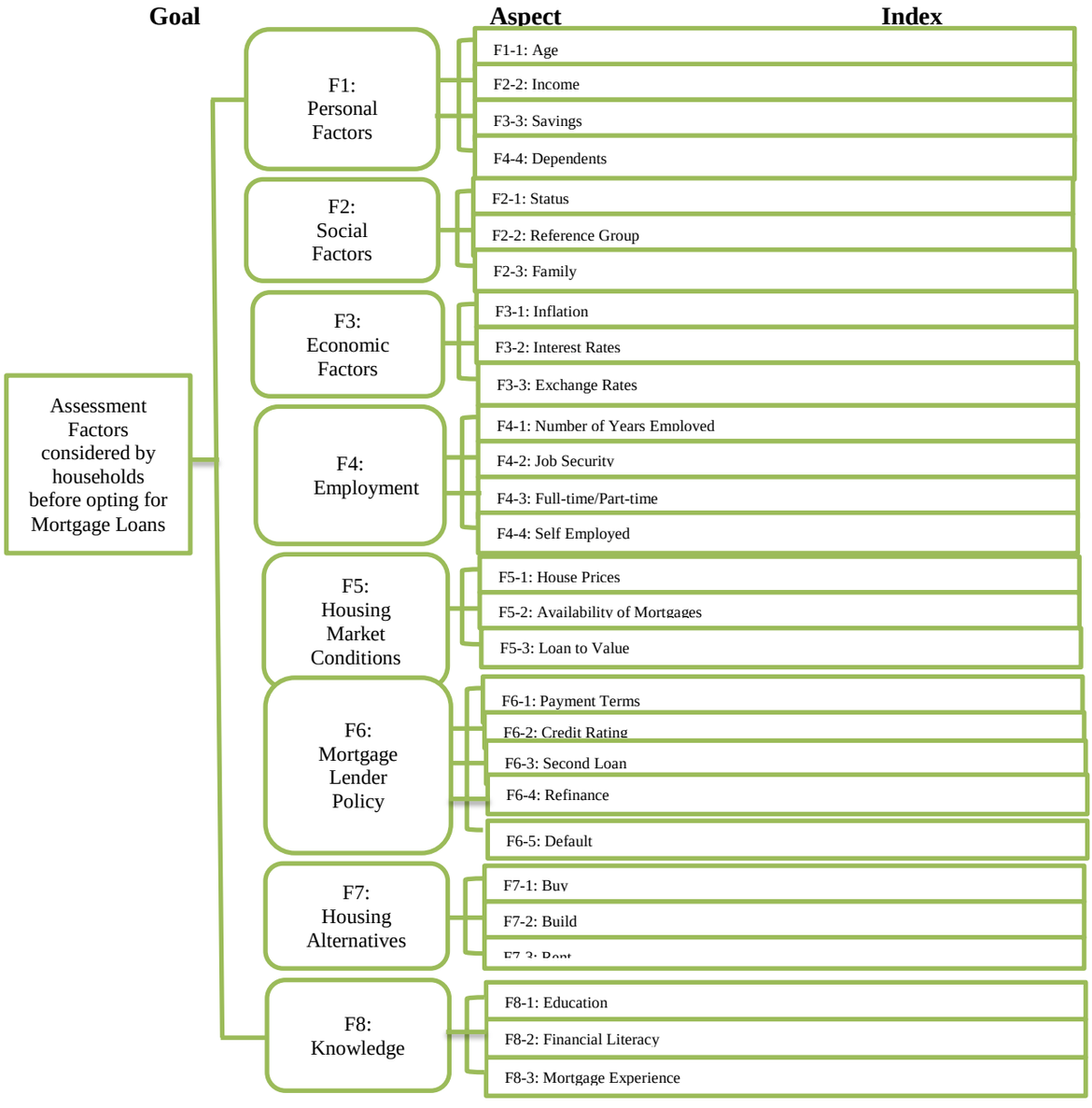

Figure 1. Hierarchical structure of household's assessment factors when acquiring a mortgage

3.2. Establishing an Assessment Model

Using AHP to analyze problems involves the following five steps: establishing a hierarchical structure, establishing a pairwise comparison matrix, calculating the eigenvalue and eigenfactor, and performing consistency tests and weight calculations. The consistency test examined whether the respondents' questionnaire answers are consistent and transitive.

The consistency test comprised two levels. First, it examined whether the constructed pairwise comparison matrix was a consistent matrix. The basis for this test was the consistency index (C.I.; Eq. 7). The second test examined whether the hierarchical structure was consistent. The basis for this test was the consistency ratio (C.R.; Eq. 8) [20].

$$C.I. = \frac{\lambda_{max}^{-n}}{n - 1} \quad (7)$$

$$C.I. = \frac{C.I.}{R.I.} \quad (8)$$

In this equation, n is the level factor number and λmax is the eigenvalue of the comparison matrix. RI is the random consistency index obtained from numerous simulations, which varies according to the order of the matrix (Table 1).

Table-1. Random Index (R.I.) Values

N	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
R.I.	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49

AHP cannot overcome the subjectivity, inaccuracy, and fuzziness generated during assessments. Therefore, we used fuzzy AHP (FAHP) as the analysis tool in this study. FAHP combines AHP and fuzzy theory, and its execution steps are largely identical to those of AHP. However, FAHP requires additional steps for establishing fuzzy linguistics, defuzzification, and normalization. FAHP is better able to resolve the clarity, vagueness, and blur of human thinking compared to AHP (Huang, 2012). During the FAHP calculation process, we adopted the column geometric mean method, "Buckley's method" (Buckley, 1985) and the extent analysis method, "Chang's method" (Chang, 1996) to calculate the weights. The steps are explained below:

Step 1. Establish a hierarchical structure

Step 2. Design a questionnaire:

Based on the established hierarchical structure, design a questionnaire that compares indicators to obtain respondents' opinions of two indicators. We used the semantic description method to allow the respondents to express their assessments and subjective judgments fully. We also used the triangular fuzzy number to express semantic judgment values. A 9-point scale was used to describe the relativity, as shown in Table 2.

Table-2. The relative importance of fuzzy ratio scales (Huang, 2012)

Relative Importance	**Linguistic Variables**	**Triangular Fuzzy Number**
$C_{ij} = 9$	Absolute Importance	(8,9,9)
$C_{ij} = 8$	Intermediate value	(7,8,9)
$C_{ij} = 7$	Very Strong Importance	(6,7,8)
$C_{ij} = 6$	Intermediate value	(5,6,7)
$C_{ij} = 5$	Essential Importance	(4,5,6)
$C_{ij} = 4$	Intermediate value	(3,4,5)
$C_{ij} = 3$	Weak Importance	(2,3,4)
$C_{ij} = 2$	Intermediate value	(1,2,3)
$C_{ij} = 1$	Equal Importance	(1,1,2)

Step 3. Establish a fuzzy positive reciprocal matrix

$$A = [a_{ij}] \quad (9)$$

where $\mathbf{a}_{ij} = (\mathbf{l}_{ij}, \mathbf{m}_{ij}, \mathbf{u}_{ij},)$, $\mathbf{l}_{ij}$, $\mathbf{m}_{ij}$, and $\mathbf{u}_{ij}$ are the lower limit, peak, and upper limit of the triangular fuzzy number:

$$\mathbf{a}_{ij} = \frac{1}{\mathbf{a}_{ij}}, \forall i, j = 1,2, \dots, n$$

Step 4. Use the geometric means method to integrate the opinions of respondents.

$$a_{ij} = (a^1_{ij} \otimes a^2_{ij} \otimes \dots \otimes a^n_{ij})^{1/n} \quad (10)$$

were $\mathbf{a}_{ij}$ is the triangular fuzzy number in the column and the row of the fuzzy positive reciprocal matrix and $\mathbf{a}^{\mathbf{n}}_{\mathbf{ij}}$ is the assessment value of respondent N. Step 5. Calculate the fuzzy weight

(1) Method 1: Column geometric mean method

$$w_i = r_i \otimes (r_1 \otimes r_2 \otimes \dots \dots \otimes r_n)^{-1} \quad (11)$$

$$r_i = (a_{i1} \otimes a_{i2} \otimes \dots \dots \otimes a^1_{in})^{1/n} \quad (12)$$

where $\mathbf{w}_i$ is the fuzzy weight value of each column in the fuzzy positive reciprocal matrix and $\mathbf{r}_i$ is the geometric mean of the triangular fuzzy number.

(2) Method 2: Extent analysis method

$$S_i = \sum_{j=1}^{m} M^j_{gi} \otimes [\sum_{i=1}^{n} \sum_{j=1}^{m} M^j_{gi}]^{-1} \quad (13)$$

$$\sum_{j=1}^{m} M^j_{gi} = [\sum_{j=1}^{m} l_j, \sum_{j=1}^{m} m_j, \sum_{j=1}^{m} u_j] \quad (14)$$

$$[\sum_{i=1}^{n} \sum_{j=1}^{m} M^j_{gi}]^{-1} = [\frac{1}{\sum_{j=1}^{m} ui}, \frac{1}{\sum_{j=1}^{m} mi}, \frac{1}{\sum_{j=1}^{m} li}] \quad (15)$$

where $\mathbf{S_i}$ is the fuzzy weight in matrix m and M^{j}_{gi} (j = 1,2, … . , m) is the triangular fuzzy number calculated after comparing the questionnaires.

After comparing each indicator, a minimum was generated for each group (Eq. 16). Assume that d'(Ai) is the minimum for each group (Eq. 17), and create a set with the minimums of each group (Eq. 18).

$$V(M \geq M_1, M_2, \ldots \ldots, M_k) = \min V(M \geq M_i), I = 1, 2, \ldots \ldots, k \quad (16)$$

$$d^*(A_i) = \min V(S_i \geq S_k) \quad (17)$$

$$W' = (d'(A_1), d'(A_2), \ldots \ldots, d'(A_n))^T \quad (18)$$

Standardize the minimums after comparison to obtain the defuzzification weights for each indicator (Eq. 19).

$$W = (d'(A_1), d'(A_2), \ldots \ldots, d'(A_n))^T \quad (19)$$

Step 6. Defuzzification: Convert the fuzzy weights into non-fuzzy values (Eq. 20).

$$DF_{ij} = \frac{a+b+c}{3} \quad (20)$$

a, b, and c are the lower limit l_{ij}, the peak (m_{ij}), and the upper limit (u_{ij}) of the triangular fuzzy number.

Step 7. Perform normalization (Eq. 21) to obtain the weights for each aspect and indicator.

$$NW_i = \frac{DF_{ij}}{\sum DF_{ij}} \quad NW_i \quad (21)$$

Step 8. Perform hierarchical tandem to calculate the global weights of all indicators.

4. Empirical Results

4.1. The Consistency Test

We used the consistency ratio (CR) to assess the reliability and credibility of the questionnaire. When CR ≦0.1, it indicates that the deviation in the respondents' estimation of each factor's weight when constructing the paired-comparison matrix was acceptable, verifying the consistency. All CR values were lower than 0.1; therefore, all the judgments are consistent. This result demonstrated the accuracy of the results of the questionnaire survey.

4.2. Weight Calculation Results

The weights and sequences for each aspect and indicator obtained using the column geometric mean method (Buckley's method) are shown in Table 3. The weights and sequences for each aspect and indicator obtained using the extant analysis method (Chang's method) are shown in Table 4. Tables 3

and 4 indicate that using either Buckley's method or Chang's method, the items households considered the most or were concerned with when opting for a mortgage loan within selection assessment aspects were, in sequential order, were, "Employment", "Housing Market Conditions", "Personal Factors", "Economic Factors", "Mortgage Lender Policy", "Housing Alternatives", "Knowledge", and "Social Factors".

Within the "Employment" aspect, households were most concerned with job security. Within the "Housing Market Conditions "aspect, house prices was the most important for households. Within the "Personal Factors" aspect, households were most concerned with savings. Within the "Economics Factors" aspect, households were most concerned with interest rates. Within the "Mortgage Lender Policy" aspect, households were most concerned with the payment terms. Within the "Housing Alternatives" aspect, households considered to build. Within the "Knowledge" aspect, financial literacy was the most important to households. Within the "Social Factors" aspect, status was the most important indicator considered by households when deciding to opt for a mortgage loan.

Table-3. Local weight and global weight for each criterion (Buckley's method)

Aspect[a]	Local Weights[b]	Ranking	Indicator[a]	Local Weights[b]	Ranking	Global Weights[c]	Ranking
			F1-1	0.124	4	0.023	22
F1	0.185	3	F1-2	0.373	2	0.069	5
			F1-3	0.400	1	0.074	3
			F2-4	0.168	3	0.031	15
			F2-1	0.400	1	0.022	23
F2	0.055	8	F2-2	0.218	3	0.012	28
			F2-3	0.273	2	0.015	27
			F3-1	0.174	3	0.017	26
F3	0.0979	4	F3-2	0.664	1	0.065	6
			F3-3	0.286	2	0.028	16
			F4-1	0.138	3	0.071	4
F4	0.254	1	F4-2	0.350	1	0.089	1
			F4-3	0.280	2	0.035	14
			F4-4	0.193	4	0.049	9
			F5-1	0.439	1	0.076	2
F5	0.173	2	F5-2	0.220	2	0.038	11
			F5-3	0.150	3	0.026	17
			F6-1	0.595	1	0.058	7
			F6-2	0.257	5	0.025	19
F6	0.0974	5	F6-3	0.452	3	0.044	10
			F6-4	0.380	4	0.037	13
			F6-5	0.544	2	0.053	8
			F7-1	0.295	2	0.023	21
F7	0.0780	6	F7-2	0.526	1	0.041	12
			F7-3	0.269	3	0.021	24
			F8-1	0.402	2	0.024	20
F8	0.0597	7	F8-2	0.436	1	0.026	18
			F8-3	0.302	3	0.018	25

a. For an explanation of the codes, please refer to Fig. 1.
b. Local weight is determined based on judgments of a single criterion.
c. Global weight is determined by multiplying the weight of the criteria.

Partial differences were observed for the sequence results obtained using Buckley's method and Chang's method in the weight sequences for the indicators within the aspects of "Housing Market Conditions (F5)", "Mortgage Lender Policy (F6)", and "Knowledge (F8)". The rankings (F5) of the two methods for Housing Market Conditions (F5-1), House Prices (F5-2), Availability of Mortgages (F4-3) and Loan-to-Value were 1-2-3 (Buckley's method) and 1-3-2 (Chang's method). The rankings (F6) of the two methods for Payment Terms (F6-1), Credit Rating (F6-2), Second Loan (F6-3), Refinance (F6-4) and Default (F6-5) were 1-5-3-4-2 (Buckley's method) and 1-4-3-5-2 (Chang's method). The rankings (F8) of the two methods for Education (F8-1), Financial Literacy (F8-2) and Mortgage Experience (F8-3) were 2-1-3 (Buckley's method) and 1-2-3 (Chang's method). The rankings for the remaining indicators within the other aspects were identical, indicating that Buckley's method and Chang's method had equivalent similarity and performance regarding identifying the important indicators.

Concerning the overall rankings for all indicators, the top ten (10) ranking of the indicator importance obtained using Buckley's method and Chang's method were identical. These indicators in order of rank were Job Security (F4-2), House Prices (F5-1), Savings (F1-3), Number of Years Employed (F4-1), Income (F1-2), Interest Rates (F3-2), Payment Terms (F6-1), Default (F6-5), Self Employed (F4-4) and Second Loan (F6-3). The rankings for the other indicators differed slightly. This was caused by differences in computation logic between the two methods.

Table-4. Local weight and global weight for each criterion (Chang's method)

Aspect[a]	Local Weights[b]	Ranking	Indicator[a]	Local Weights[b]	Ranking	Global Weights[c]	Ranking
F1	0.137	3	F1-1	0.102	4	0.035	13
			F1-2	0.327	2	0.067	5
			F1-3	0.352	1	0.072	3
			F2-4	0.205	3	0.036	11
F2	0.057	8	F2-1	0.557	1	0.016	25
			F2-2	0.034	3	0.010	28
			F2-3	0.293	2	0.019	24
F3	0.118	4	F3-1	0.040	3	0.024	17
			F3-2	0.651	1	0.063	6
			F3-3	0.097	2	0.026	16
F4	0.245	1	F4-1	0.116	3	0.069	4
			F4-2	0.905	1	0.087	1
			F4-3	0.903	2	0.039	12
			F4-4	0.096	4	0.047	9
F5	0.199	2	F5-1	0.835	1	0.074	2
			F5-2	0.029	3	0.024	18
			F5-3	0.109	2	0.029	15
F6	0.105	5	F6-1	0.674	1	0.056	7
			F6-2	0.062	4	0.021	21
			F6-3	0.159	3	0.042	10
			F6-4	0.031	5	0.020	23
			F6-5	0.321	2	0.051	8
F7	0.131	6	F7-1	0.172	2	0.023	19
			F7-2	0.192	1	0.033	14
			F7-3	0.076	3	0.013	27
F8	0.060	7	F8-1	0.220	1	0.022	20
			F8-2	0.157	2	0.021	22
			F8-3	0.097	3	0.015	26

a. For an explanation of the codes, please refer to Fig. 1.
b. Local weight is determined based on judgments of a single criterion.
c. Global weight is determined by multiplying the weight of the criteria.

5. Conclusions

The study sought to determine the Considerations made by households before deciding on acquiring a mortgage loan. After critically assessing the data obtained from mortgage owners within the Accra Metropolis, an FAHP was used to analyze the weights of the decision-making aspects and indicators considered by consumers when selecting home stays. The results indicate that the sequence of the four items with the highest weights of all the aspects were "Employment", "Housing Market Conditions", "Personal Factors", and "Economic Factors". The total weights for these four aspects were 0.7099 (Buckley's method) and 0.6970 (Chang's method). The least important items among the factors considered by households when deciding to acquire a mortgage loan "Mortgage Lender Policy", "Housing Alternatives", "Knowledge" and "Social Factors". The total weight for these four aspects was 0.2901 (Buckley's method) and 0.3030 (Chang's method).

The four areas under consideration for mortgage lenders are: "Employment"; the rate of employment within the nation is crucial for the mortgage market to be successful. Job security an essential factor in the demand consideration or decision process of households in relation to opting for a mortgage loan, the longer a person has been in their job the safer they feel hence their likelihood in opting for a mortgage loan. Government should look to create more jobs within the economy to enhance the mortgage market.

The "Housing Market Conditions", price is a huge demand consideration factor. The prices of houses in Ghana are rather on the higher side hence this needs for it to be reviewed. Furthermore mortgage loans are not easily available to households and seems to be synonymous to a select few namely the rich and affluent of the society. Making mortgages loans available for more class categories will help solve this issue. Finally the loan-to-value is essential as households believe that the loan they are able to acquire should help them purchase the house of their choice or dreams and that they should have some satisfaction in the value.

Thirdly "Personal Factors", such as income, amount in savings, dependents and age of individuals also affect demand considerations. Better per capita income, interest on savings and packages from mortgage lenders for families can help households in this criteria.

Lastly, "Economic Factors", most importantly interest rates on repayments of mortgages need to be reasonable. Furthermore, "Exchange Rates" in Ghana as a demand consideration is not surprising as the nation is very dependent on the dollar. Most houses are sold in dollars on the housing market and fluctuations in exchange rates can make house prices rise when the dollar appreciates against the cedi. Causing its own form of inflation. Law on house pricing in local currency is imperative to help this criteria.

In conclusion households who want to acquire properties should acquire properties through mortgages because of its long life span and it ability of freeing up capital for further income generation.

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