Calibrated fuzzy AHP for current bank account selection

Alessio Ishizaka *, Nam Hoang Nguyen

University of Portsmouth, Portsmouth Business School, Richmond Building, Portland Street, Portsmouth PO1 3DE, United Kingdom

1. Introduction

Despite the popularity and simplicity of the Analytic Hierarchy Process (AHP), it is often criticised for its inability to adequately handle the uncertainty of a decision maker’s preferences. In classic AHP, the judgements are represented by crisp values. To overcome these shortcomings, fuzzy AHP has been developed to take into account this uncertainty and imprecision. It is essentially the combination of two methods: fuzzy set theory and AHP (Van Laarhoven & Pedrycz, 1983). Fuzzy set theory requires the definition of a membership function. At present, there are no indications of how these membership functions can be constructed. In this paper, a way to calibrate the membership functions with comparisons given by the decision-maker on alternatives with known measures is proposed. This new technique is illustrated in a study measuring the most important factors in selecting a student current account.

2. Fuzzy AHP

Fuzzy AHP was first proposed by Van Laarhoven and Pedrycz (1983) and is an extension of AHP combined with fuzzy set theory (Zadeh, 1965). The main advantage of this combination is that it makes allowances for the vagueness and imprecision of human preference. The key idea is that a certain degree of an element belongs to a fuzzy membership set, which is given by a function depicted on a two-axis diagram. The horizontal axis consists of the domain elements of the fuzzy sets and the vertical axis the degree of membership on a scale of 0–1. These membership functions can take several shapes: linear, S-curves, triangular or trapezoidal representations. In practice, triangular and trapezoidal membership functions are the most frequently used. They can be denoted by membership of \( \mu_A \) where \( \mu_A \) is defined by:

\[
\mu_A(x) = \begin{cases} \frac{x-l}{m-l}, & l \leq x \leq m \\ 1, & x = m \\ \frac{m-x}{m-u}, & m \leq x \leq u \\ 0, & \text{otherwise} \end{cases}
\]

Fuzzy AHP is based on 4 steps:

(a) For each linguistic term of the evaluation scale, a membership function is constructed.

(b) Criteria/alternatives are pair-wise compared in comparison matrix \( \tilde{A} \)

\[
\tilde{A} = \begin{bmatrix} \tilde{a}_{11} & \tilde{a}_{12} & \ldots & \tilde{a}_{1n} \\ \tilde{a}_{21} & \tilde{a}_{22} & \ldots & \tilde{a}_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ \tilde{a}_{n1} & \tilde{a}_{n2} & \ldots & \tilde{a}_{nn} \end{bmatrix}
\]

where \( \tilde{a}_{ij} \) is the fuzzy comparison between criterion/alternative \( i \) and \( j \).

(c) Fuzzy priorities are derived from comparison matrix \( \tilde{A} \). This is done using the eigenvalue method (3) or any other method used in traditional AHP (Ishizaka & Labib, 2011).

* Corresponding author. Tel.: +44 23 92 844171.
E-mail addresses: Alessio.Ishizaka@port.ac.uk (A. Ishizaka), nhnam1988@gmail.com (N.H. Nguyen).
3. Membership function calibration

The calibration of the membership function is performed through a comparison of measurable alternatives. In our case, we used geometrical figures but it is possible for other items to be used (Fig. 2). The participants were asked to compare their surface with the verbal scale given in Table 2. They were also informed that the figures were in an increasing order, so the questionnaire only had one scale direction (Table 3), e.g. A is necessarily smaller than B. Not all comparisons are required for the calibration; therefore only one scale direction (Table 3), e.g. A is necessarily smaller than B. Not all comparisons are required for the calibration; therefore only a subset was asked to avoid overwhelming the participants. The measured pairwise comparisons of the figures are given in Table 4.

The verbal judgements (Table 3) given by the decision-maker are matched with the real values (Table 4). For example, suppose that the decision-maker evaluates a “very strong” difference between figures G and A, D and A and also between Fig. 1 and B. The real values of these three evaluations (i.e. 7, 4, 4.5) are entered into the matching table (Table 5). Therefore, it can be deduced that the decision maker values outcomes of between 4.5 and 7 as “very strong”.

All the judgements matched with the real measures are entered into a Table 5. For each verbal judgement, the minimal, mean and maximal values are calculated. They correspond to the angle points of the customised membership function. Fig. 3 represents the customised membership functions of all verbal judgements. Notice that these membership functions are not similar (e.g. the wideness of the membership function “very strong” is much larger than “moderate”) because they depend on the person’s interpretation of verbal judgements.

4. Case study

4.1. Introduction

The development of an appealing product may have a long-term impact on the profitability of companies. This is especially true in the banking sector, where students often remain with the same bank when they leave education. Students are not a profitable segment of the market because their income is low, however they are the potentially high earner in the future. As a result, it is in the best interests of the bank to attract and retain these customers early.

This explorative study will give an insight into the most important criteria in selecting a student bank account using calibrated fuzzy AHP, described in Section 3.

4.2. Criteria description

In the literature there are several studies for bank selection in different countries: Romania (Katircioglu, Tumer, & Kilinc, 2011a); Ghana (Hinson, Owusu-Frimpong, & Dasah, 2011; Mahmoud, Tweneboah-Koduah, & Danku, 2011); USA (Lee & Marlowe, 2003), Northern Cyprus (Katircioglu, Unlucan, & Dalci, 2011b; Safakli, 2007); Malaysia (Ahmad, Rustam, & Dent, 2011; Amin, 2008; Mokhlis, Saleh, & Mat, 2011); Greece (Lymeropoulos, Chaniotakis, & Sourel, 2006); Bahrain (Al-Ajmi, Abo Hussain, & Al-Saleh, 2009; Almossawi, 2001); United Kingdom (Devlin & Gerrard, 2005; Farquhar & Panther, 2008; Thwaitesa & Verea, 1995); Singapore (Ta & Har, 2000), Poland (Kennington, Hill, & Rakowska, 1996); Hong Kong (Denton & Chan, 1991); India (Gupta & Dev, 2012). Each study has its own list of criteria. As the utilisation of AHP becomes difficult with a large number of criteria, similar factors were grouped together (Table 6) and structured into a hierarchy (Fig. 4). This also avoids the problem of overweighting dependent criteria (e.g. internal and external bank appearance).

Some criteria have not been considered because:

- They are out-dated, for example, ATM service. Banks have a consensus scheme to share ATM information systems, therefore; a person can withdraw cash either free of charge or for a small fee from any ATM belonging to another bank.
- They are outside the control of the banks, such as recommendations from friends and relatives. Some studies also suggest that these criteria are negligible in bank account selection (Almossawi, 2001; Ta & Har, 2000).

4.3. Demography of the participants

Forty participants of the University of Portsmouth were recruited in a sample of equal gender and nationality proportions (Table 7).

Participants are aged between 19 and 30 (Table 8). Twenty-three students are on a bachelor course and 17 on a master’s level course. Only participant P36 had full-time work experience of more than six months.

4.4. Questionnaire collection mode

To increase the response rate, different collection channels were used:

- E-mail: This collection mode has a low associated cost (no printing and postage) and is timesaving as a large population can be targeted at once. The questionnaire was sent to 75 students. Twenty-five questionnaires were returned but only 14 were correctly completed. The perceived disadvantage of this
دریافت فوری
متن کامل مقاله

امکان دانلود نسخه تمام متن مقالات انگلیسی
امکان دانلود نسخه ترجمه شده مقالات
پذیرش سفارش ترجمه تخصصی
امکان جستجو در آرشیو جامعی از صدها موضوع و هزاران مقاله
امکان دانلود رایگان ۲ صفحه اول هر مقاله
امکان پرداخت اینترنتی با کلیه کارت های عضو شتاب
دانلود فوری مقاله پس از پرداخت آنلاین
پشتیبانی کامل خرید با بهره مندی از سیستم هوشمند رهگیری سفارشات