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Calibrated Fuzzy AHP for current bank account selection

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Abstract:

Fuzzy AHP is a hybrid method that combines Fuzzy Set Theory and AHP. It has been developed to take into account uncertainty and imprecision in the evaluations. 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.

Keywords: Fuzzy AHP, membership functions, customisation, current account, banking

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 exact values on a scale of 1 to 9 (Saaty, 1977, 1980). However, in many real cases, the linguistic assessments of human evaluations are often vague, and it is not realistic to represent them with crisps 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 for each verbal judgement. However, in all papers reviewed, there was no indication of how the membership functions have been selected. This paper proposes a way to calibrate the membership functions with comparisons given by the decision-maker on alternatives with known measures. In this case, we asked to compare the surface of geometrical figures and as a result, the membership function was personalised for each participant. Then, the fuzzy AHP with the customised membership functions is applied to a case study in order to establish the most important factors in the selection of a student current account. We found that service is the most weighted criteria when selecting a bank account.

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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 to 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 $\tilde{A} = (l, m_l, m_u, u)$, where $l \leq m_l \leq m_u \leq u$ correspond to lower, modal-lower, modal-upper and upper bound, i.e. the trapezium's angle points. If the membership is triangular, then $m_l = m_u$ (Figure 1). The membership of $\tilde{A}$ is defined by:

$$\mu_{\tilde{A}}(x) = \begin{cases} \dfrac{x-l}{m-l}, & l \leq x \leq m \\ 1, & x = m \\ \dfrac{u-x}{u-m}, & m < x < u \\ 0, & otherwise \end{cases} \quad (1)$$

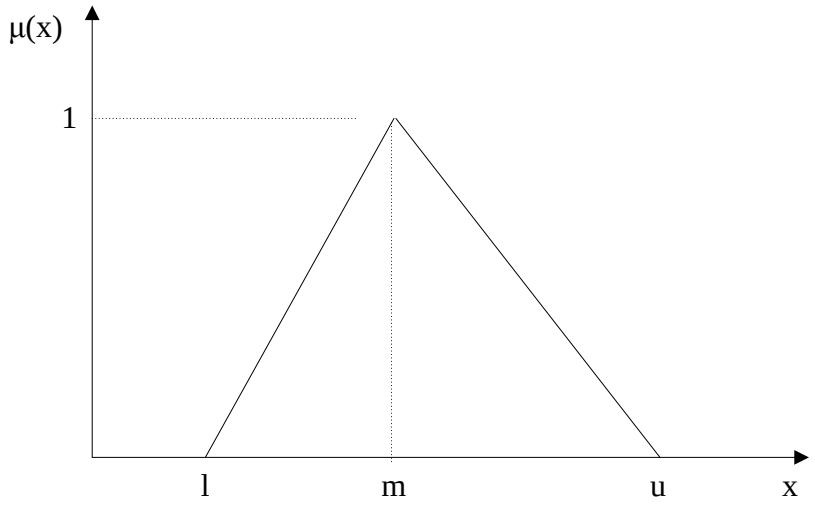

Figure 1: Trapezoidal membership function

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 $\tilde{A}$.

$$\tilde{A} = \begin{bmatrix} \tilde{a}_{11} & \tilde{a}_{12} & ... & \tilde{a}_{1n} \\ \tilde{a}_{21} & \tilde{a}_{22} & ... & \tilde{a}_{2n} \\ ... & ... & ... & ... \\ \tilde{a}_{n1} & \tilde{a}_{n2} & ... & \tilde{a}_{nn} \end{bmatrix} \quad (2)$$

where $\tilde{a}_{ij}$ is the fuzzy comparison between criterion/alternative *i* and *j*

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

$$\tilde{A} \cdot \tilde{p} = \lambda \cdot \tilde{p} \quad (3)$$

d) As these fuzzy priorities must be ranked, they need to be translated into real numbers to make the ranking more obvious than fuzzy numbers. Several methods exist including the weighted average approach, the centre of area, the mean-max membership and the first (or last) of maxima. The most popular is the centre of area or centroid (Van Leekwijck & Kerre, 1999).

Except for the fuzzy representation of the judgement scale, the steps of fuzzy AHP are the same as traditional AHP (Ishizaka & Labib, 2011). Therefore, this paper will concentrate on the fuzzy membership function that represents the judgement scale. In the literature review, we found 27 different representations of fuzzy membership functions (Table 1), however none have been justified. Li and Kuo (2008) are the only one to ask the decision-maker to construct their own membership function but do not give any guidance on how to fulfil this task. This paper presents a new way to construct a personalised membership function. The methodology will be illustrated by a case study in banking.

(A. Lee, Chen, & Chang, 2008; Paksoy, Pehlivan, & Kahraman, 2012; Şen & Çınar, 2010; Zeydan, Çolpan, & Çobanoğlu, 2011)	(Y.-L. Hsu, Lee, & Kreng, 2010; Yuen & Lau, 2011)	(Alev Taskin, 2009; M.-K. Chen & Wang, 2010; Chia-Chi, 2010; S. H. Hsu, Kao, & Wu, 2009; Wu, Lo, & Hsu, 2008)	(Büyüközkan & Çifçi, 2012; Lo & Wen, 2010)	(H. Chen, Lee, & Tong, 2007; Lu & Wang, 2011)
(1,1,1)	(1,1,1)	(1,1,1)	(1,1,2)	(1,1,3)
(1,2,3)	(1,2,3)	(1,2,3)	(1,2,3)	(1,2,4)
(2,3,4)	(2,3,4)	(2,3,4)	(2,3,4)	(1,3,5)
(3,4,5)	(3,4,5)	(3,4,5)	(3,4,5)	(2,4,6)
(4,5,6)	(4,5,6)	(4,5,6)	(4,5,6)	(3,5,7)
(5,6,7)	(5,6,7)	(5,6,7)	(5,6,7)	(4,6,8)
(6,7,8)	(6,7,8)	(6,7,8)	(6,7,8)	(5,7,9)
(7,8,9)	(7,8,9)	(7,8,9)	(7,8,9)	(6,8,9)
(9,9,9)	(8,9,9)	(8,9,10)	(8,9,10)	(7,9,9)

(Cho & Lee, 2011)	(Javanbarg, Scawthorn, Kiyono, & Shahbodaghkhan, 2012)	(L.-C. Chen & Chu, 2012)	(Özkır & Demirel, 2012)	(Önüt, Efendigil, & Soner Kara, 2010)
(0,1,2) (1,2,3) (2,3,4) (3,4,5) (4,5,6) (5,6,7) (6,7,8) (7,8,9) (8,9,9)	(0.5,1,2) (1,2,3) (2,3,4) (3,4,5) (4,5,6) (5,6,7) (6,7,8) (7,8,9) (8,9,10)	(1,1,2) (1,2,3) (2,3,4) (3,4,5) (4,5,6) (5,6,7) (6,7,8) (7,8,9) (8,9,9)	(1,1,1) or (1,1,2) (2,3,4) (4,5,6) (6,7,8) (8,9,9) (1,1,1) only if an element is compared with itself, otherwise (1,1,2) if the user thinks they are equal	(1,1,1) or (1,1,3) (1,3,5) (3,5,7) (5,7,9) (7,9,9) (1,1,1) only if an element is compared with itself, otherwise (1,1,3) if the user thinks they are equal
(Mentes & Helvacioglu, 2012)	(Bulut, Duru, Keçeci, & Yoshida, 2012; Cebeci, 2009; Duru, Bulut, & Yoshida)	(Haghighi, Divandari, & Keimasi, 2010; S.-H. Lee, 2010)	(Bozbura, Beskese, & Kahraman, 2007; Isaai, Kanani, Tootoonchi, & Afzali, 2011; T.-C. Wang & Chen, 2011)	(Che, Wang, & Chuang, 2010)
(1.00,1.00,1.25) (1.25,1.50, 1.75) (1.75,2.00, 2.25) (2.25,2.50,2.75) (2.75,3.00,3.00)	(1,1,1) (1,3,5) (3,5,7) (5,7,9) (7,9,9)	(1,1,1) (1/2,1,3/2) (1,3/2,2) (3/2,2,5/2) (2,5/2,3) (5/2,3,7/2)	(1.0,1.0,1.0) (0.5,1.0,1.5) (1.0,1.5,2.0) (1.5,2.0,2.5) (2.0,2.5,3.0) (2.5,3.0,3.5)	(1,1,1) (1,2,3) (2,3,4) (3,4,5) (4,5,6) (5,6,7) (6,7,8)
(Iç & Yurdakul, 2009)	(Hosang, 2011)	(Seçme, Bayrakdaroğlu, & Kahraman, 2009)	(Hadi-Vencheh & Mohamadghasemi, 2011)	(Nepal, Yadav, & Murat, 2010)
(1,1,1) (2,3,4) (4,5,6) (6,7,8) (8,9,10)	(1,1,2) (1,3,5) (3,5,7) (5,7,9) (8,9,9)	(1,1,1) (2/3,1,3/2) (1,3/2,2) (3/2,2,5/2) (5/2,3,7/2)	(1,1,2) (1,2,3) (2,3,4) (3,4,5) (4,5,5)	(1,1,3) (1,3,5) (3,5,7) (5,7,9) (7,9,11)
(Celik, Deha Er, & Ozok, 2009; Kilincci & Onal, 2011; Liu &	(Büyüközkan, Çifçi, & Güleryüz, 2011; T.-S. Li &	(Cakir & Canbolat, 2008; J. Wang, Fan, & Wang,	(Kaya & Kahraman, 2011a, 2011c; Kutlu & Ekmekçioğlu,	(Celik, Kandakoglu, & Er, 2009; Durán &

Chen, 2009; Rostamzadeh & Sofian, 2011)	Huang, 2009)	2010)	2012)	Aguilo, 2008)
(1,1,1) (2/3,1,3/2) (3/2,2,5/2) (5/2,3,7/2) (7/2,4,9/2)	(1,1,2) (2,3,4) (4,5,6) (6,7,8) (8,9,10)	(1,1,2) (2,3,4) (4,5,6) (6,7,8) (8,9,9)	(1,1,1) (1,1,1.5) (1,1.5,2) (1.5,2,2.5) (2,2.5,3)	(1,1,3) (1,3,5) (3,5,7) (5,7,9) (7,9,9)
(Kaya & Kahraman, 2011b)	(Iç & Yurdakul, 2009)	(S. Li & Kuo, 2008)	(Chiang & Che, 2010; Ho, 2012; Ou, Fu, Hu, Chu, & Chiou, 2011)	
(1,1,1,1) (1,3/2,2,5/2) (3/2,2,5/2,3) (2,5/2,3,7/2) (5/2,3,7/2,4)	(1,1,1,1) (2,3,4,5) (4,5,6,7) (6,7,8,9) (8,9,10,10)	Decision-maker constructs their own membership function.	Not mentioned	

Table 1: Different definitions of membership function for the fuzzy scale

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 (Figure 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 a subset was asked to avoid overwhelming the participants. The measured pairwise comparisons of the figures are given in Table 4.

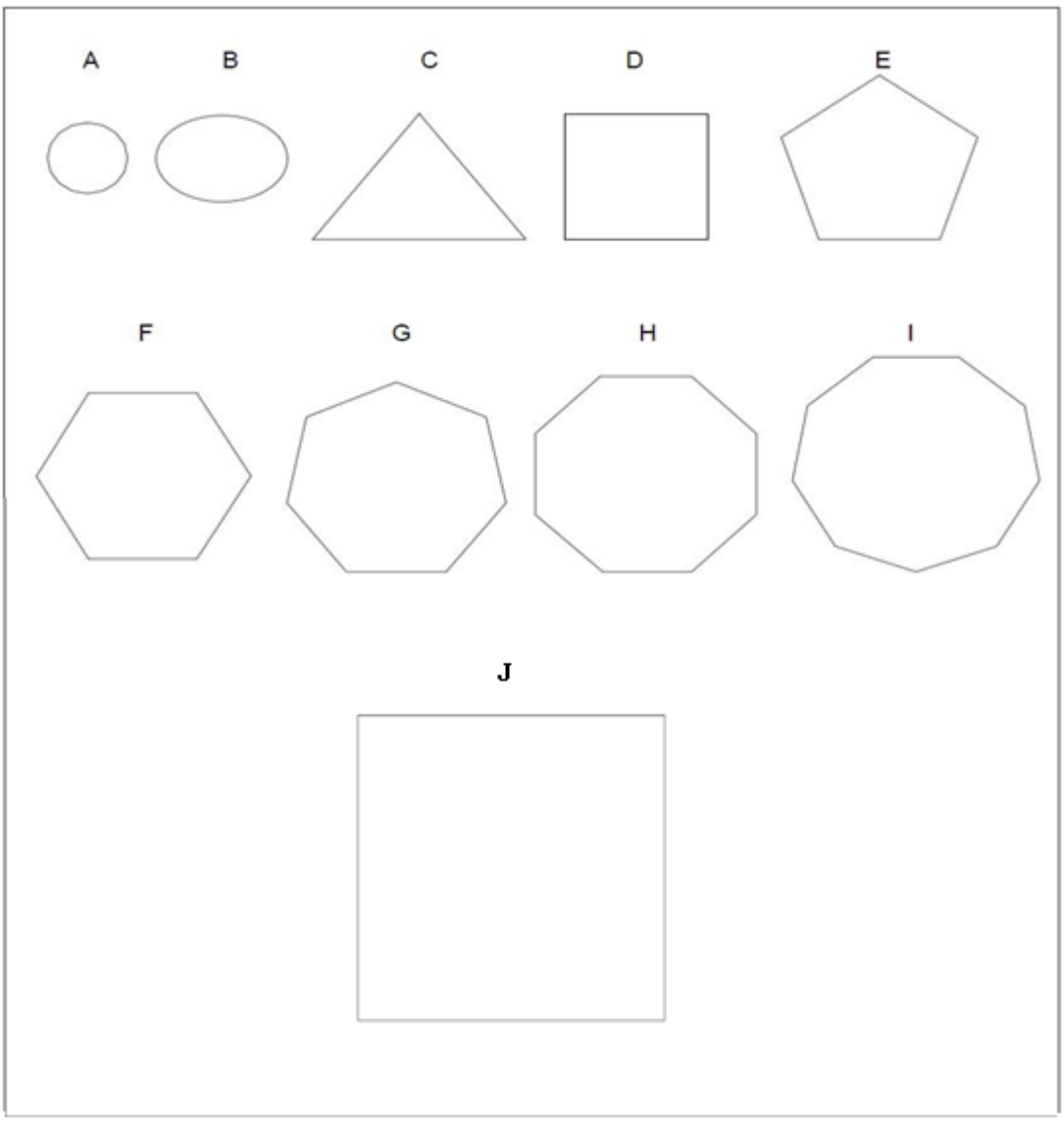

Figure 2: Geometrical figures

Abbreviation	Definition
Equ	Equal size
Eq/mod	Equal to Moderately different
Moderate	Moderately different
Mod/Str	Moderately to strongly different
Strong	Strongly different
Str/verStr	Strongly to very strongly different
Ver Str	Very strongly different
verStr/Extr	Very strongly to extremely different
Ext	Extremely different

Table 2: Evaluation scale

Figure I	How much Figure I is bigger than Figure II?									Figure II
B	Equal	Eq/mode	moderate	mod/str	strong	str/verstr	verstr	verstr/ext	Extreme	A
C	Equal	Eq/mode	moderate	mod/str	strong	str/verstr	verstr	verstr/ext	Extreme	A
D	Equal	Eq/mode	moderate	mod/str	strong	str/verstr	verstr	verstr/ext	Extreme	A
E	Equal	Eq/mode	moderate	mod/str	strong	str/verstr	verstr	verstr/ext	Extreme	A
F	Equal	Eq/mode	moderate	mod/str	strong	str/verstr	verstr	verstr/ext	Extreme	A
G	Equal	Eq/mode	moderate	mod/str	strong	str/verstr	verstr	verstr/ext	Extreme	A
H	Equal	Eq/mode	moderate	mod/str	strong	str/verstr	verstr	verstr/ext	Extreme	A
I	Equal	Eq/mode	moderate	mod/str	strong	str/verstr	verstr	verstr/ext	Extreme	A

Table 3: Extract of the questionnaire

	A	B	C	D	E	F	G	H	I	J
A										
B	2									
C	3	3/2								
D	4	4/2	4/3							
E	5	5/2	5/3	5/4						
F	6	6/2	6/3	6/4	6/5					
G	7	7/2	7/3	7/4	7/5	7/6				
H	8	8/2	8/3	8/4	8/5	8/6	8/7			
I	9	9/2	9/3	9/4	9/5	9/6	9/7	9/8		
J		10/2	10/3	10/4	10/5					

Table 4: Real measured pairwise comparisons; comparison is not done for empty squares

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 figure I 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 (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. Figure 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.

Scale	Equal	Eq/ Mod	Moderate	Mod/ Str	Strong	Str/ very Str	Very Strong	Ver str/ extreme	Extreme
Participant judgements	1.20	2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00
	1.00	1.33	1.50	2.33	2.50	3.00	4.00	4.50	
		1.40	2.00	1.50	2.67	3.50	4.50	9.00	
		1.60	1.67	1.75	2.67	3.60		6.00	
		1.17	2.00	2.00	3.00				
		1.33	1.25	1.50	2.25				
		1.14	1.80						
		1.29							
		1.13							
p(min)	1.00	1.13	1.25	1.50	2.25	3.00	4.00	4.50	9.00
p(mean)	1.10	1.38	1.89	2.18	3.01	4.03	5.17	6.88	9.00
p(max)	1.20	2.00	3.00	4.00	5.00	6.00	7.00	9.00	9.00

Table 5: Matching table

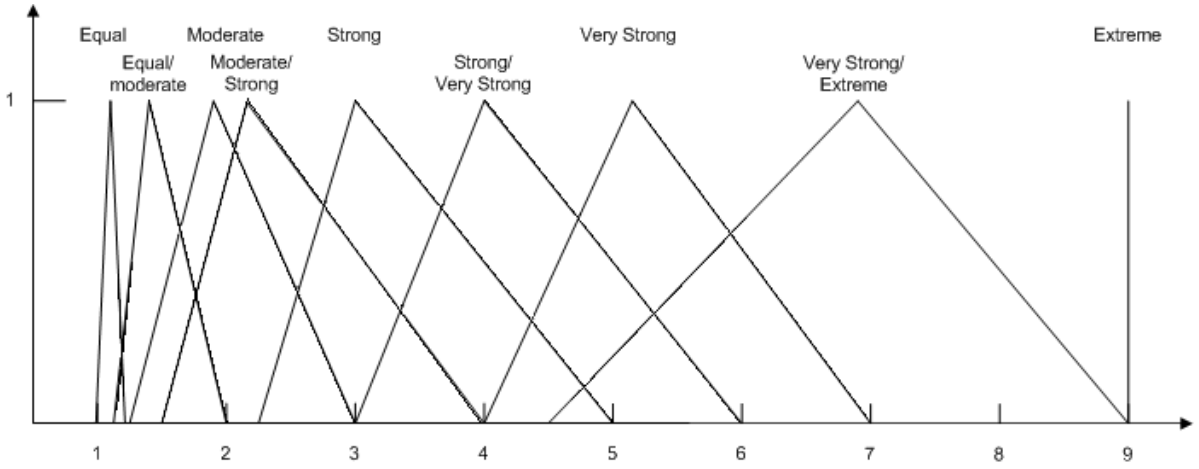

Figure 3: Customised membership functions

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, & Kılınç, 2011); Ghana (Hinson, Owusu-Frimpong, & Dasah, 2011; Mahmoud, Tweneboah-Koduah, & Danku, 2011); USA (J. Lee & Marlowe, 2003), Northern Cyprus (Katircioglu, Unlucan, & Dalci, 2011; Safakli, 2007); Malaysia (Ahmad, Rustam, & Dent, 2011; Amin, 2008; Mokhlis, Salleh, & Mat, 2011); Greece (Lymperopoulos, Chaniotakis, & Soureli, 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 (Figure 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).

Services Intangible provisions to the customer define the bank services.	- **Personnel service quality**: *efficiency and competence* (Al-Ajmi, et al., 2009; Blankson, et al., 2009; Gupta & Dev, 2012; Hinson, et al., 2011; Katircioglu, Tumer, et al., 2011; Laroche, et al., 1986; Lymperopoulos, et al., 2006; Manrai & Manrai, 2007; Mokhlis, et al., 2011; Safakli, 2007; Thwaitesa & Verea, 1995) *and consistency* (Lymperopoulos, et al., 2006) *of the personnel, staff friendliness* (Al-Ajmi, et al., 2009; Almossawi, 2001; Hinson, et al., 2011; Laroche, et al., 1986; Mahmoud, et al., 2011; Safakli, 2007), *speed of the service* (Blankson, et al., 2009; Gupta & Dev, 2012; Katircioglu, Tumer, et al., 2011; Lymperopoulos, et al., 2006; Thwaitesa & Verea, 1995)
	- **Banking service features:** *Card type (cash, debit or credit card) with favourable conditions* (Katircioglu, Tumer, et al., 2011), *accessibility to the account (internet banking, phone banking)*

	(Al-Ajmi, et al., 2009; Almossawi, 2001; Blankson, et al., 2009; Devlin & Gerrard, 2005; Katircioglu, Tumer, et al., 2011; Mahmoud, et al., 2011; Ta & Har, 2000), *ease of opening a current account* (Almossawi, 2001), *hours of operations* (Al-Ajmi, et al., 2009; Almossawi, 2001; Devlin & Gerrard, 2005; Gupta & Dev, 2012; Kamvysi, et al., 2010; Katircioglu, Tumer, et al., 2011; Kennington, et al., 1996; Laroche, et al., 1986; Manrai & Manrai, 2007; Ta & Har, 2000), *international funds transfer* (Mahmoud, et al., 2011)
	- **Building quality**: *Branch location* (Al-Ajmi, et al., 2009; Almossawi, 2001; Blankson, Omar, & Cheng, 2009; Devlin & Gerrard, 2005; Gupta & Dev, 2012; Kamvysi, Gotzamani, Georgiou, & Andronikidis, 2010; Katircioglu, Tumer, et al., 2011; J. Lee & Marlowe, 2003; Lewis, 1981; Mahmoud, et al., 2011; Mokhlis, et al., 2011; Safakli, 2007; Thwaitesa & Verea, 1995), *parking facilities and accessibility* (Al-Ajmi, et al., 2009; Almossawi, 2001; Gupta & Dev, 2012; Kamvysi, et al., 2010; Laroche, Rosenblatt, & Manning, 1986; Mahmoud, et al., 2011; Safakli, 2007), *external bank appearance* (Hinson, et al., 2011; Katircioglu, Tumer, et al., 2011; Manrai & Manrai, 2007; Safakli, 2007), *bank decor and atmosphere (e.g. waiting lounge, drinking water)* (Al-Ajmi, et al., 2009; Gupta & Dev, 2012; Katircioglu, Tumer, et al., 2011; Manrai & Manrai, 2007; Mokhlis, et al., 2011)
Financial Factors The financial factors are defined by a direct monetary benefit.	- **Charges***: Low fees or charges* (Almossawi, 2001; Blankson, et al., 2009; Devlin & Gerrard, 2005; Gupta & Dev, 2012; Kamvysi, et al., 2010; Katircioglu, Tumer, et al., 2011; J. Lee & Marlowe, 2003; Lymperopoulos, et al., 2006; Mokhlis, et al., 2011; Thwaitesa & Verea, 1995)
	- **Interest rates***: High interest rates* (Al-Ajmi, et al., 2009; Almossawi, 2001; Devlin & Gerrard, 2005; Gupta & Dev, 2012; Kamvysi, et al., 2010; Katircioglu, Tumer, et al., 2011;

	Kennington, et al., 1996; J. Lee & Marlowe, 2003; Lymperopoulos, et al., 2006; Manrai & Manrai, 2007; Ta & Har, 2000).
	- **Overdraft Facilities***: Overdraft availability and size* (Kamvysi, et al., 2010; Lewis, 1981; Thwaitesa & Verea, 1995)
Extra benefits Extra benefits given by the bank when opening an account. They are often related to the students' life offering things such as travel discounts and laptop vouchers.	- **Bonuses**: *A one-off gift given when opening or switching accounts* (Katircioglu, Tumer, et al., 2011; Lewis, 1981; Mokhlis, et al., 2011). *It could be a cash-back offer* (Blankson, et al., 2009), *or music to download, a SIM card, an iPod, etc.*
	- **Incentives***: Incentives are available as long as the account is open* (Devlin & Gerrard, 2005). *This includes mobile or car insurance, extra top-ups on mobile phones, discounts on travel or shopping, discounted international payments, etc.*

Table 6: Bank selection criteria

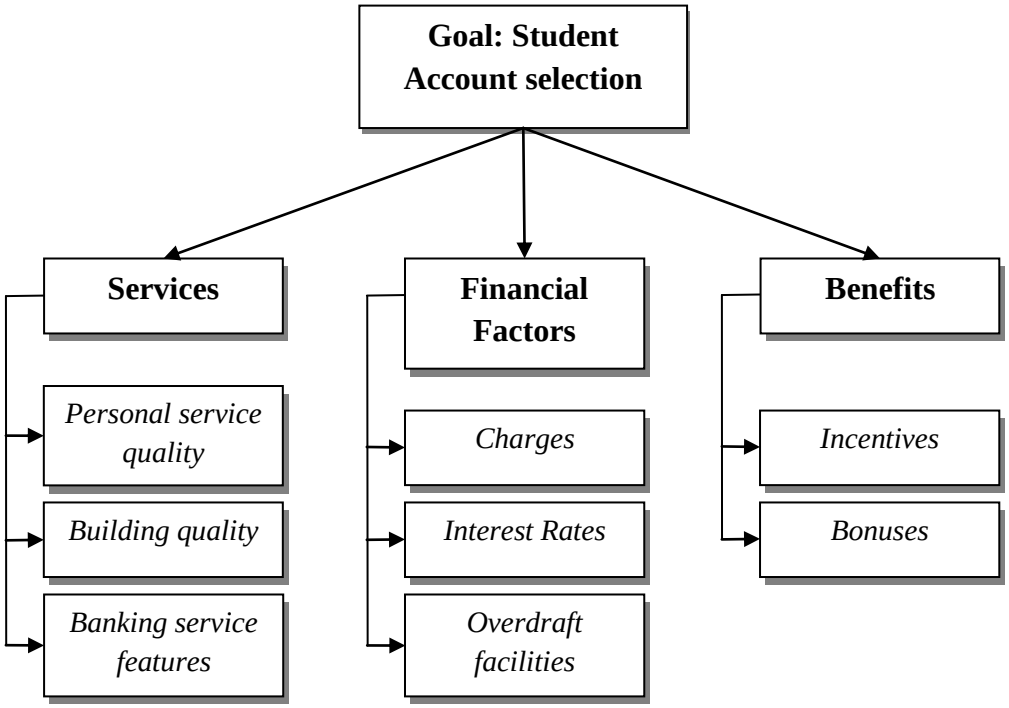

Figure 4: Hierarchy of the criteria

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).

Table 7: Sample selection of the study

	Male	Female
British student	10	10
International student	10	10

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

Table 8: Demography of the participants

#	Course	Age	Gender	Nationality
P1	MsC Finance	27	M	British
P2	BA Accounting and Finance	19	F	Vietnamese
P3	MsC Business and Management	24	F	Indian
P4	MA Marketing	24	F	Thailand
P5	MsC Business and Management	23	F	Vietnamese
P6	BsC Business and Economic	20	F	British
P7	MsC Business and Management	25	M	Vietnamese
P8	BsC Biology	21	M	British
P9	BA Accountancy and Financial Management	20	F	British
P10	BA Computing	21	F	British
P11	BsC Crime and Criminology	24	M	British
P12	MsC Financial Decision Analysis	23	M	Vietnamese
P13	BA Digital Marketing	22	F	British
P14	MsC Financial Decision Analysis	25	M	Malaysian
P15	BsC Digital Forensics	22	M	British
P16	MsC Finance	26	M	Chinese
P17	MsC Construction Project Management	27	M	British
P18	BA Education and Training studies	22	F	British
P19	BA English Literature	20	F	Chinese
P20	BA Business Administration	19	M	Malaysian
P21	MsC Forensic Accounting	25	M	Chinese
P22	BA Business Enterprise	20	M	Indian
P23	BA Accounting and Business	21	M	Vietnamese
P24	MsC Finance	23	M	Chinese
P25	MsC Business and Management	25	F	British
P26	BA Business with Business Communication	20	M	Vietnamese
P27	MsC Finance	23	M	British
P28	FdA Policy Studies	26	M	British
P29	BsC Web and Game Technology	20	M	British

P30	MsC Finance	27	M	British
P31	BsC Accounting and Finance	20	M	British
P32	MsC Finance	23	F	Chinese
P33	MsC Business and Economic	24	F	British
P34	MsC Business and Management	23	F	Vietnamese
P35	MsC Finance	25	F	Vietnamese
P36	MsC Human Resource Management	30	F	British
P37	MA Marketing	25	F	Vietnamese
P38	MsC Finance	25	F	British
P39	MA Sale Management	24	F	British
P40	MsC Coach and Development	26	F	Chinese

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 seventy-five students. Twenty-five questionnaires were returned but only fourteen were correctly completed. The perceived disadvantage of this collection mode is the relatively low response rate (33%) and the delays between the dates the email was sent and getting a reply.

- **Face-to-face communication**: This channel allows interaction with the participants, in particular, the relevance of the study can be emphasised and instructions can be repeated if necessary. Forty people were approached, thirty agreed to complete the questionnaire (65% response rate) but only nineteen were fit for use. This collection mode is more time consuming than the other methods.

- **Social network:** This channel has a large outreach, low cost and is timesaving. The questionnaire was posted onto the university Facebook page, however very few responses were received (twenty) and only seven could be used. This was the lowest usable rate of the three channels (Table 9).

Table 9: Modes of data collection

Mode of communication	Questionnaire distributed	N° of responses	N° of usable responses	Responses rate	Usable response rate
Email	75	25	14	33%	56%
Face to face	40	30	19	75%	63.33%
Social network	High	20	7	(Very low)	35%
Total	**115 to high**	**75**	**40**	**n/a**	**n/a**

A questionnaire is considered valid if fully completed and has consistent pairwise comparisons. In this study, twenty questionnaires were incomplete and fifteen were inconsistent.

For each participant, a matching table (e.g. Table 5) has been constructed and a customised scale has been calculated. The results were then imported into Expert Choice, where priorities were obtained with Fuzzy AHP and aggregated in a group decision using the geometric mean.

4.5. Results

Table 10 summaries the importance of the criteria for selecting a current account. The average consistency is very high, which indicates that the participants have a clear view of their priorities.

These results support previous studies highlighting the importance of services in bank account selection, in particular the personal service quality. The second most important criterion was bonuses, which proved to be more attractive than long-term incentives. Financial factors have the lowest score. This may be explained by the low income of students and their inability to invest.

The British and international students (Comparison I, Table 10) had very similar scores. International students scored slightly higher for the criterion services and slightly lower for financial factors. Being unfamiliar with British banking systems, it is understandable that they would prefer a good personal service with tailored explanations. The employees should also understand their particular needs. Financial factors were not so important as they tend to leave the country after graduation. Their bank accounts are used as a deposit base rather than an investment instrument. It is also not surprising that they prefer immediate bonus rather than incentives that stop with the closure of the account.

The female and male expectations are slightly different (Comparison II, Table 10). Females have a slight preference for better services and financial factors, whilst males prefer the benefits criterion.

Table 10: Importance of criteria for current account selection

Comparisons / Criteria	Overall	Comparison I		Comparison II		Comparison III	
		Home	Inte-rnational	Females	Males	Under-graduate	Post-graduate
Number of participants	**40**	**20**	**20**	**20**	**20**	**17**	**23**
Services	***44.5%***	***42.5%***	***46.3%***	***46.5%***	***42.2%***	***40.6%***	***47.1%***
Personal service quality	*19.9%*	*19.3%*	*20.4%*	*20.9%*	*18.7%*	*17.9%*	*21.3%*
Building quality	*11.1%*	*9.5%*	*12.8%*	*10.9%*	*11.2%*	*10.8%*	*11.1%*
Banking service features	*13.5%*	*13.8%*	*13.2%*	*14.8%*	*12.2%*	*11.9%*	*14.7%*
Financial Factors	***22.1%***	***24.0%***	***20.3%***	***24.3%***	***20.0%***	***20.4%***	***23.3%***
Charges	*8.7%*	*9.2%*	*8.3%*	*9.7%*	*7.8%*	*8.8%*	*8.6%*
Interest rates	*6.5%*	*7.6%*	*5.5%*	*7.5%*	*5.6%*	*5.8%*	*6.9%*
Overdraft facilities	*6.9%*	*7.3%*	*6.5%*	*7.2%*	*6.6%*	*5.8%*	*7.7%*
Benefits	***33.4%***	***33.4%***	***33.4%***	***29.3%***	***37.9%***	***39.0%***	***29.6%***
Bonuses	*18.6%*	*17.5%*	*19.7%*	*16.5%*	*20.8%*	*20.9%*	*16.9%*
Incentives	*14.8%*	*16.0%*	*13.6%*	*12.7%*	*17.1%*	*18.0%*	*12.7%*
Inconsistency rate	0%	0%	0%	0%	0%	0%	0%

Undergraduate students rate the Benefits criterion very highly (39%), almost as high as the services (40.6%) (Comparison III, Table 10). Postgraduates prefer the services by almost half of the weight (47.1%).

5. Conclusion

The contribution of this study can be viewed from both a theoretical and practical dimension. Theoretically, this paper presents a new customised fuzzy-AHP method. Practically, it provides insight into criteria selection for bank accounts among students.

When data are precisely known, they can be represented with crisps numbers. However, in most real-world situations, data cannot be assessed precisely because it is unquantifiable, incomplete, undisclosed or vague. Decision-makers are often uncertain in assigning the evaluation with conventional AHP, therefore a hybrid multi-criteria technique is used. Linguistic terms have been introduced to better mirror the vagueness and subjectivity of the evaluation. These are then translated into numerical values with fuzzy formats described by membership functions. In previous work, the construction of membership functions was never discussed and was the same for every decision-maker. In this paper, a new process to calibrate these functions according to the decision-maker's subjectivity is proposed. This

significantly contributes to more precise and customised results. The methodology provides an effective tool for evaluating fuzzy representations and for modelling subjective and ambiguous situations. Due to the customisation of each personal verbal evaluation, the tool's adaptability is enhanced for multiple criteria group decision-making problems in a 'fuzzy' situation.

To illustrate this new customised fuzzy-AHP method, a study on the importance of the criteria for selecting a bank account for students was conducted. As the research was for illustrative purposes, it should be considered explorative. The sample was small but some conclusions were drawn nevertheless. The face-to-face collection of data was the most effective collection method, with a much higher response rate and consistency index. The study highlighted once more in the academic literature the importance of service in the banking sector and found that financial factors were less important. Bonuses were more attractive to international students and therefore; it is not surprising that several UK banks prefer to offer bonuses than attractive financial conditions. It is essential to understand the preference of the consumer and to have a strategic design in place to meet their expectations. The findings of the study serve as a starting point for bank managers to understand the importance of the selection criteria, however, further studies on a larger scale are needed to confirm these observations.

On the methodological part, the fuzzy calibration methodology is very versatile and flexible in its areas of applications and integration with other methods. Future studies could combine the fuzzy calibration methodology with other MCDA techniques, such as TOPSIS, PROEMTHEE and ELECTRE.

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