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A Successful Strategy of Online P2P Lending using ANP-Fuzzy TOPSIS Method: Focusing on Updated IS Success Model

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Abstract: This study investigates core factors that influence the online P2P lending and their relationships in selecting the most preferred online P2P lending website. Based on IS success model with ANP and fuzzy TOPSIS, the research conducts an evaluation model. The ANP is used for determining weights of updated IS success model's criteria, fuzzy sets are adopted to recommend ambiguity with linguistic values and TOPSIS is a useful tool to get final ranking on the list. The study was examined by 6 e-Business specialists. This study investigates the online P2P lending with updated IS success model. The major results of this study offer the online P2P lending company decision makers with valuable information to enhance business quality. First, trust is an extremely essential factor than others within an online P2P lending website. Because all transactions are conducted in the virtual space, lenders and borrowers can only meet in the online platform during the financial transactions. If they don't trust these websites, they can't deal with a contract. Second, in the online P2P lending, the information quality posted has much influence on trust and satisfaction. The investors who participate in this online market intend to investigate borrower's information from this site before making investment decisions. Finally, this study suggests efficient operating scheme in this field.

Key words: The online P2P lending, updated IS success model, ANP, fuzzy TOPSIS, linguistic values, company

INTRODUCTION

Online P2P lending brings transformed businesses and redefines the roles of traditional financial intermediaries (Guo *et al*., 2016). It is a virtual marketplace where both lenders and borrowers can meet for loans. There are several online P2P lending platforms in South Korea such as auction money, POP funding, Keeping funding, 8%, TERA funding, Lendit, Funda, etc. It is expected that loans lead by the P2P lenders in the South Korea alone will reach 110 million dollars by 2016. The online P2P lending relies on the integrated information system which has the possibility to increase cost-efficiency of the financial market (Guo *et al*., 2016). On the other side, the online P2P lending involves high risks because most lenders of the online P2P lending are lack of financial know-how and these transactions are processes without enough collateral (Lee and Lee, 2012). Thus, new decision-making factors are necessary to discuss for the online P2P lending such as IS success model.

This study includes three objectives: first, measuring the relative importance of the online P2P lending success factors by using updated IS success model (Delone and McLean, 2003). Second, investigating alternatives of the online P2P lending and designing a more accurate online P2P lending business model for loan service which deriving personal investors to optimize investment decisions (Guo *et al*., 2016). Finally, suggesting online P2P lending strategy and providing decision support framework for assessing online P2P business strategy carefully.

Literature review

Evaluating online P2P lending success: IS success model is an often cited model that considers with e-Business success including the information system quality (Delone and McLean, 2003). This model can be measured in core categories of the new e-Commerce environment. Especially, updated IS success model can prove the relationships of mutual information system dimensions including system quality, information quality and service quality. These will in turn have direct and indirect effects on use and user satisfaction. Additionally, use and user satisfaction are antecedents to net-benefit singularly and jointly. This model does not have a general linear structure but a network cycle structure (Wu *et al*., 2010). Lee and Kozar (2006) applied IS success model including

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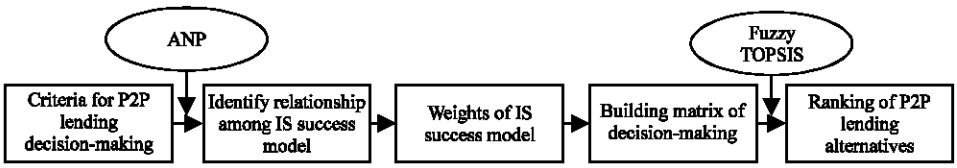

Fig. 1: The online P2P lending success strategy

vender-specific quality for investigating the most preferred website. Keramati and Salehi (2013) evaluated website quality using integrated tools of IS success model and ANP.

Online P2P lending success strategy ANP fuzzy TOPSIS framework: ANP, developed by Saaty (1996) has been adopted for tracking Multiple Criteria Decision Making (MCDM) of the real applications (Wu *et al*., 2010; Keramati and Salehi, 2013). MCDM methods are suggested to be one of the most useful methodologies for important decision makings of vague and ill-defined problems. It is ANP to measure network structure and feedback mechanism by ratio scale. The TOPSIS is a MCDM tool based on distance that adopted for determining alternatives (Saaty, 1996). Fuzzy TOPSIS is extended to the fuzzy calculations and fuzzy index (Yu *et al*., 2011). Furthermore, MCDM such as fuzzy TOPIS has been adopted by a list of alternatives under uncertain or conflicting attributes (Wu *et al*., 2010; Mohammadi *et al*., 2014). As indicated in Fig. 1, a five step configuration of ANP and fuzzy TOPSIS was integrated to build a model toanalyze online P2P lending success.

Research model: The IS success model was appropriate for measuring the quality of thegeneral websites. However, as the online P2P lending belongs to the emerging commerce, so that, it needs a fresh method for conceptualizing quality (Lee and Lee, 2012). Based on the previous literatures of the evaluation of IS success (Delone and McLean, 2003) such as quality of website on e-Business success (Lee and Kozar, 2006), success of website comparison perspective of ANP (Keramati and Salehi, 2013), evaluation of e-Commerce based on E-S-QUAL (Kang *et al*., 2016). As a result, we developed the online P2P lending success model by classifying attributions into the seven dimensions and 10 sub-criteria set of Table 1: information quality, system quality, service quality, satisfaction, trust and use. This study presents a research model for online P2P lending criteria weights (Fig. 2).

According to Keramati and Salehi (2013), updated IS success model has a network structure. They adopt this

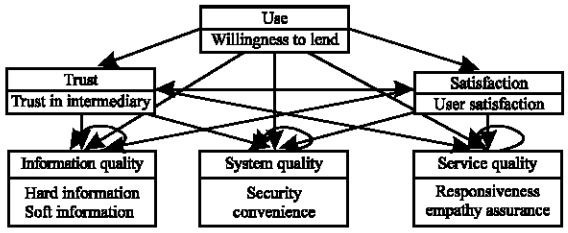

Fig. 2: ANP Model for using P2P lending

model with ANP method for investigating the importance of each IS factor in alternative websites. The detailed discussionsare as follows: information quality of information producing and delivering takes account of a core factor for IS success. Traditionally, information quality is measured through information relevance, currency and understandability. But hard information (such as personal deposit certification, the reimbursementrecord) and soft information (such as frequency of communication on the online channel), more importantly, they are measured within online transaction (Lee and Lee, 2012). System quality, considering derives from IS performance related to the prompt and accurate process, also is a primary reasonthat influencing adoption (Lee and Kozar, 2006) of technology. Here, we consider two factors that are security and convenience (Keramati and Salehi, 2013). Service quality refers to supportive activities, direct and indirect such as the kind and quick client response, useful functions (Chen *et al*., 2014). This can provide more smooth and pleasant experience. Guo *et al*. (2016) have stated that, it is necessary to support the valuable and pleasant experience to elicit an investment. Therefore, many researchers refer to the importance of trust in an e-Commerce environment. It can reduce the risk of uncertainty related with anonymous online transaction (Gefen *et al*., 2003). The online transaction has three trust parties involved with the intermediary, the seller and the buyer (Pavlou and Gefen, 2004). In the online P2P marketplace, transaction processes consider, not only vendor's various characteristics but also information of the intermediary (Greiner and Wang, 2010). Previous studies indicate that user-satisfaction is a critical factor for system adoption (Keramati and Salehi, 2013).

Table 1: Online P2P lending success measures

References	Updated IS success model	Online P2P lending success measures	Definition
Lee and Lee (2012)	Information quality	Hard information	The history of whether payments were made in right time, stock returns and vast output numbers on the online P2P lending
		Soft information	The history of frequent communications in bulletin board on online the P2P lending
Keramati and Salehi (2013)	System quality	Security	Protection of personal information when using the online P2P lending
		Convenience	Ease of navigation
Keramati and Salehi (2013)	Service quality	Responsiveness	Giving prompt service, amount of time it takes to get information about the borrower
		Empathy	Virtual assistant, offering online P2P lending product and services to lender
		Assurance	Report of experience of other lenders
Keramati and Salehi (2013)	Satisfaction	User satisfaction	The experience of satisfaction about the online P2P lending
Chen *et al.* (2014)	-	Trust (Trust in intermediary)	Protection of the interests of lenders in the online P2P lending
Chen *et al.* (2014)	Use	Willingness to lend	Willingness to lend through the online P2P lending

Satisfaction has been often defined as a feel of happiness or contentment. When a customer gets enough satisfaction from the vendor, they feel stable and tend to stay in a business (Abdinnour-Helm *et al*., 2005). The online P2P lending is based on the mutual trust and using satisfaction by lenders, borrowers and intermediary. Both who have used the website and who continue to share the idea with others originate from individual experiences (Ashta and Assadi, 2009). Table 1 shows the measurement items and operation definitions.

MATERIALS AND METHODS

Calculating the criteria weights using ANP: ANP is the MCDM allowing decision makers to deal with the complicated problem in a network structure (Yu *et al*., 2011). ANP is the feedback approach which is appropriate for deriving priorities into interdependent influences. The ANP is founded on the following.

Step 1: ANP is composed as a network structure. ANP is decomposed into a network structure such as hierarchy structure of intertwined with decision criteria. Within the ANP, the objectives, criteria and alternatives have been arranged in a network framework. Figure 2 shows overall goal (use) and numerous criteria that defined alternatives as trust, satisfaction, information quality, system quality, service quality.

Step 2: Set up a pair-wise comparison matrix. Since, the pair-wise comparison can identify the vis-a-vis weight of criteria, all criteria are assigned to pair-wise matrix on the basis of their influential relationship into the network structural:

$$W = \begin{array}{c} \\ C_1 \\ C_2 \\ C_m \end{array} \begin{array}{c} \begin{array}{ccc} C_1 & C_2 & C_m \end{array} \\ \begin{bmatrix} w_{11} & w_{12} & w_{1m} \\ w_{21} & w_{22} & w_{2m} \\ w_{m1} & w_{m2} & w_{mm} \end{bmatrix} \end{array} \quad (1)$$

$$\lim_{k\to\infty} W_k \quad (2)$$

Step 3: W is a transformation matrix. It entries are structured of the vectors calculated from this matrix. W refers to a column stochastic matrix, its limited priorities reliance upon the reduce and network group of that matrix. If the matrix is irreducible, the limited figure is attained via. rising W to powers such as in Eq. 2 for obtaining the global priority vectors. Finally, each assessorhas been conducted through pairwise comparisons for calculating each criterion weights based on Table 1. The calculation of each pairwise comparison was conducted with nine-point scale. Consistency ratio of the pair-wise comparison was <0.1 (Table 2).

Linguistic variables and fuzzy numbers: In fuzzy MCDM, the key performance indicator is usually outlined by fuzzy sets. The alternative has been evaluated through a total of all criteria weights and alternatives ratings in which alternatives with a higher utility are preferential. According to fuzzy sets, steps are outlined in the following.

Step 1; Establishing fuzzy number: In the universe of discourse X, a fuzzy sets $\tilde{A}$ is dominated by a fuzzy membership function $\mu_{\tilde{a}}(x)$. It relates with each component x in X a real value in the range of 0-1. The function value $\mu_{\tilde{a}}(x)$ is ranked by membership function of x in $\tilde{A}$. This study concentrates on triangular fuzzy numbers (Fig. 3). The a_1 and a_2 refer to interval of low and high the fuzzy number. $\tilde{A}$ and a_2 refers to the modal value for $\tilde{A}$ (Eq. 3):

$$\mu_{\tilde{a}}(x) = \begin{cases} 0 & x \le a_1 \\ \dfrac{x-a_1}{a_2-a_1} & a_1 \le x \le a_2 \\ \dfrac{a_3-x}{a_3-a_2} & a_2 \le x \le a_3 \\ 0 & x \le a_3 \end{cases}$$

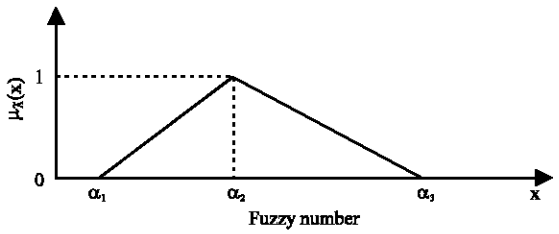

Fig. 3: The membership functions of the triangular fuzzy number

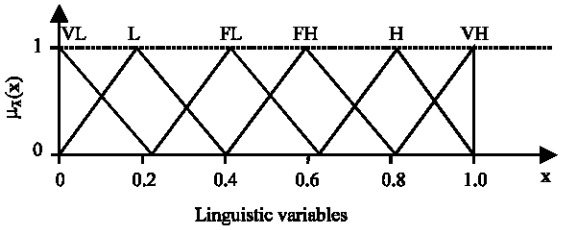

Fig. 4: The membership functions of linguistic variables

Table 2: Online P2P lending criteria weight by updated IS success model

Criteria	Updated IS success models	Values
C1	Information quality	0.106121
C2	Service quality	0.034185
C3	System quality	0.066497
C4	Trust	0.531609
C5	Satisfaction	0.261587

Table 3: Linguistic value and triangular fuzzy number

Linguistic values	Triangular fuzzy number
Very Low (VL)	(0, 0, 0.2)
Low (L)	(0, 0.2, 0.4)
Fairly Low (FL)	(0.2, 0.4, 0.6)
Fairly High (FH)	(0.4, 0.6, 0.8)
High (H)	(0.6, 0.8, 1)
Very High (VH)	(0.8, 1, 1)

Step 2: Evaluating the linguistic values (x_{ij}). Figure 4 shows linguistic variables that were used as ratings of triangular fuzzy numbers consist of (0, 1) with normalization. The triangular fuzzy numbers listed in Table 3 were incorporated into the computation.

Step 3: Constructing the weighted fuzzy matrix with normalization. The weighted fuzzy matrix value is derived via. Eq. 4. Where, w_j can be get in ANP:

$$v_{ij} = x_{ij} * w_j \; i = 1, 2, 3, \cdots, m; j = 1, 2, 3, \cdots, n \quad (4)$$

Finally, 6 specialists participated in this investigation. They are evaluated online P2P lending criteria. And, we transformed linguistic variables in Table 3. It is conducted through comparing five alternatives under five cluster criteria that information quality, service quality, system quality, trust and satisfaction. The matrix is showed in Table 4. According to Eq. 4, a fuzzy weighted decision matrix has been demonstrated in Table 5.

Ranking online P2P lending alternatives using fuzzy-TOPSIS: The TOPSIS measurement tool has been proposed by Chen and Hwang (2012) and Moayeri *et al.* (2015). The selected alternative should be the minimum distance between the ideal solution (or Positive-Ideal Solution; PIS). It can obtain the maximized benefit. In contrary, the maxima distance is the Negative-Ideal Solution (NIS). It is the worst performance values of the alternatives.

Although, TOPSIS is a kind of useful MCDM, this approach also has some potential defects which related to the unpredictability of human perception and vagueness. The fuzzy TOPSIS has been used to solve these problems. Since, fuzzy TOPSIS use fuzzy sets which are linguistic value, decision-makers can handle complication, fragmentary information and insufficient evidence of the facts. The fuzzy TOPSIS supports better modeling method in thecomplex environment. The fuzzy TOPSIS has been conducted with steps based on the following Eq. 5.

Step 1: Determine Fuzzy Positive-Ideal Solution (FPIS) and the Fuzzy Negative-Ideal Solution (FNIS). The FPIS (A^*) and FNIS (A^-) are indicated in the following Eq. 5 and 6. Where A^* is relevant to benefit criteria and A^* is relevant to cost criteria. Table 6 shows FPIS ($\tilde{v}_i^*$) and FNIS ($\tilde{v}_i^-$):

$$A^* = \{v_1^*, \cdots, v_m^*\} = \{(\max_j v_{ij} \mid i \in I')(\min_j v_{ij} \mid i \in I'')\} \quad (5)$$
$$i = 1, 2, \cdots, m; j = 1, 2, \cdots, n$$

$$A^- = \{v_1^-, \ldots, v_n^-\} = \{(\min_j v_{ij} \mid i \in I'), (\max_j v_{ij} \mid i \in I'')\} \quad (6)$$
$$i = 1, 2, \ldots, m; j = 1, 2, \ldots, n$$

Step 2: Estimate the TOPSIS values of each alternative from $A^* = \{\tilde{v}_m^*\}$ and $A^- = \{\tilde{v}_n^-\}$ using the following Eq. 7 and 8. Fuzzy TOPSIS operation base on the two triangular fuzzy members that suppose a = (a_1, a_2, a_3) in Table 6 and b = (b_1, b_2, b_3) in Table 5. The distance between them is calculated as Eq. 9. Table 7 shows the fuzzy set D_i^* and D_i^- result:

$$D_i^* = \sum_{j=1}^{n} d(v_{ij}, v_j^*) \; i = 1, 2, \cdots, m \quad (7)$$

$$D_i^- = \sum_{j=1}^{n} d(v_{ij}, v_j^-) \; i = 1, 2, \cdots, m \quad (8)$$

Table 4: Fuzzy evaluation results for 5 alternatives

Criteria	A1	A2	A3	A4	A5
C1	FH (0.4, 0.6, 0.8)	H (0.6, 0.8, 1)	VH (0.8, 1, 1)	FL (0.2, 0.4, 0.6)	VH (0.8, 1, 1)
C2	H (0.6, 0.8, 1)	H (0.6, 0.8, 1)	VH (0.8, 1, 1)	FL (0.2, 0.4, 0.6)	H (0.6, 0.8, 1)
C3	FH (0.4, 0.6, 0.8)	H (0.6, 0.8, 1)	H (0.6, 0.8, 1)	L (0, 0.2, 0.4)	H (0.6, 0.8, 1)
C4	VH (0.8, 1, 1)	FH (0.4, 0.6, 0.8)	VH (0.8, 1, 1)	FH (0.4, 0.6, 0.8)	H (0.6, 0.8, 1)
C5	H (0.6, 0.8, 1)	FH (0.4, 0.6, 0.8)	H (0.6, 0.8, 1)	FL (0.2, 0.4, 0.6)	H (0.6, 0.8, 1)

Table 5: Result from fuzzy evaluation and weight

Criteria	A1	A2	A3	A4	A5
C1	0.042, 0.064, 0.085	0.021, 0.027, 0.034	0.053, 0.066, 0.066	0.106, 0.213, 0.319	0.209, 0.262, 0.262
C2	0.064, 0.085, 0.106	0.021, 0.027, 0.034	0.053, 0.066, 0.066	0.106, 0.213, 0.319	0.157, 0.209, 0.262
C3	0.042, 0.064, 0.085	0.021, 0.027, 0.034	0.040, 0.053, 0.066	0.000, 0.106, 0.213	0.157, 0.209, 0.262
C4	0.085, 0.106, 0.106	0.014, 0.021, 0.027	0.053, 0.066, 0.066	0.213, 0.319, 0.425	0.157, 0.209, 0.262
C5	0.064, 0.085, 0.106	0.014, 0.021, 0.027	0.040, 0.053, 0.066	0.106, 0.213, 0.319	0.157, 0.209, 0.262

Table 6: $\tilde{v}_i^*$ and $\tilde{v}_i^-$ for nine criteria

Criteria	$\tilde{v}_i^*$	$\tilde{v}_i^-$
C1	(0.8, 1, 1)	(0.2, 0.4, 0.6)
C2	(0.8, 1, 1)	(0.2, 0.4, 0.6)
C3	(0.6, 0.8, 1)	(0, 0.2, 0.4)
C5	(0.8, 1, 1)	(0.4, 0.6, 0.8)
C6	(0.6, 0.8, 1)	(0.2, 0.4, 0.6)

Table 7: Fuzzy TOPSIS result

Variables	D_i^*	D_i^-	CC_i	Rank
A1	4.074	1.558	0.277	3
A2	4.087	1.553	0.275	4
A3	3.602	0.887	0.198	5
A4	3.974	2.386	0.375	1
A5	3.483	1.565	0.310	2

$$d(\tilde{a}, \tilde{b}) = \sqrt{\frac{1}{3}\left[(a_1-b_1)^2+(a_2-b_2)^2+(a_3-b_3)^2\right]} \quad (9)$$

Step 3: Estimate similarities to ideal solution by the following Eq. 10:

$$CC_i = \frac{D_i^-}{D_i^*+D_i^-} \quad (10)$$

Finally, similarities to ideal solution calculations can be fulfilled for the other online P2P lending and the results are summarized in Table 7. As value of the CC_i, the online P2P lending ranking is A4, A5, A1, A2 and A3 in descending order.

RESULTS AND DISCUSSION

In this study, we suggest an evaluation model that integrates updated IS success model and ANP fuzzy TOPSIS for the online P2P lending websites. This study composed of five main stages. First, we suggested research framework. It is important to evaluate alternatives with regard to a real phenomenon which derive investment intention. Second, we defined the research problem. In detail, the online P2P lending has been selected as the evaluating alternatives and the updated IS success's evaluation tool has been identified. Third, the updated IS success factors have been computed. In this stage, a decision structure composingof ANP has been illustrated and the major dimensions and their components have been calculated. Forth, fuzzy sets evaluation of this value. In detail, the weights obtained from ANP with decision-making process via fuzzy TOPSIS calculation. Finally, the ranking order has been decided according to the weights.

The major contributions of this study are summarized as follows. First, as an improvement of previous studies which focusing on the appraisal of the online P2P lending websites with ANP fuzzy TOPSIS methods, we proposed our study based on updated IS success model. This method is the most important one that can acquire networks between the major dimensions and other sub-components through conserving the key concepts of the updated IS success quality and can enable more meaningful explanations. Second, from the results of our study, we found a useful tool, the ANP fuzzy TOPSIS for ranking the online P2P lending websites. This method can evaluate ambiguity and subjectivity with linguistic values parameterized. Finally, the proposed approach method is more reasonable than other MCDM and it can be applied to the online commerce evaluation. This approach can extend the evaluation method of e-Commerce websites which offers suggestions for other information systems to improve their operations.

CONCLUSION

The results provide guidance, so that, decision makers can obtain competitive power via. the investigation in their limited capability and resources.This study provides a research framework for easy understanding which can be followed by practitioners and researcher to determine the suitable environment for online P2P lending.

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