Measuring the Quality of Financial Electronic Payment System: Combined with Fuzzy AHP and Fuzzy TOPSIS

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ABSTRACT

The study aims to apply Fuzzy AHP in TOPSIS to discuss the key factors that foster the success of current third-party online payment platforms. This study organized the quality measurements into four categories and eleven sub-categories. The AHP in TOPSIS is applied to calculate the weighted averages of all categories and sub-categories to measure the quality of third-party online payment platforms. This study finds that “safety quality” is the most emphasized category, “system quality” is the second, “communication quality” is the third, and “service quality” is the least emphasized.

Keywords: Fuzzy AHP, fuzzy TOPSIS, e-payment.

INTRODUCTION

In recent years, with the development of Internet technology, financial electronic payment system is growing (Remington & Dent, 2000). Not only the online payment can solve the physical path of time and labor problems, but also can provide an environment of safe, fast and a lot of convenient advantages (Jiang, Yang, & Jun, 2013; Ponte, Carvajal-Trujillo, & Escobar-Rodriguez, 2015). At present, financial electronic payment can be largely divided into internet banking (Martins, Oliveira, & Popović, 2014), mobile payment (Slade, Dwivedi, Piercey, & Williams, 2015) and third-party online payment (Huang, Dai, & Liang, 2014; Roy & Venkateswaran, 2014).

In addition, with the network services provided by the function more and more complex (De Groot, Alkemade, Braat, Hein, & Willemen, 2010), internet service is open to the global environment. In fact, the security issues are also worthy of attention (Aderonke, 2010). So choose the appropriate network service evaluation criteria, taking into account the subjective and objective safety factors (Kim, Tao, Shin, & Kim, 2010), should be based on the user's security level requirements (Ramos-de-Luna, Montoro-Ríos, & Liébana-Cabanillas, 2016).

Owing to past researches in online e-payment were only for the choice of single-normative style (Koulayev, Rysman, Shuh, & Stavins, 2016), but in today's online trading environment, the decision-making problem faced by the user is complex and changeable (Lei, Yayla, & Kahai, 2017). That is to say, users often faced with the choice is not a single criterion can be used to solve (Oat, 2016). But rather to consider the various assessment criteria to which the same program belongs, and make the most appropriate choice (King, O’rourke, & DeLongis, 2014). In this way, multi-criteria decision-making (MCDM) become a method often used by decision makers (Zhang, 2016). Therefore, this study will apply multi-criteria decision-making method to assist financial electronic e-payment users in a number of possible options. According to the characteristics of each attribute of each program, make each program a sort of merit, then evaluate and select the ideal solution for the user.

Overall, this study will use the ideal solution similarity to prepare the order assessment adjustment method as a network service recommendation method (Nilashi & Ibrahim, 2014). To obtain reliable network service content satisfaction with trust range (Azmi et al., 2016), and then use the hierarchical analysis method to obtain the user's feedback weight (Chaudhary & Upreti, 2016). That is to say, the establishment of a trusted electronic payment network service recommendation mechanism (Dahlberg, Guo, & Ondrus, 2015).

LITERATURE REVIEW

From the literature to explore the main criteria can be divided into system quality, communication quality, service quality and safety quality (Ye, Fu, & Law, 2016; Zhou, 2014). System quality can be divided into ease of use and response speed of the two sub-criteria (Mishra & Singh, 2015; Zhou, 2014). Communication quality can be divided into accuracy, immediacy and integrity of the three sub-criteria (Yang, Lu, Chau, & Gupta, 2017; Zhou, 2013, 2014). Service quality is divided into reliability, trust, user satisfaction three sub-criteria (Zhou, 2013). Security quality can be divided into network security, system security, transaction security three sub-criteria (Leone & Adams, 2016). Financial electronic payment program; mainly divided
into online banking, mobile payments and third party payments (Dahlberg, Mallat, Ondrus, & Zmijewska, 2008; M. Fisher, 2013; Herzberg, 2003).

In the field of e-commerce information system success model, known as the IS model (Delone & McLean, 2003; Iivari, 2005). It consists of six variables with relevant variables. The success factor of the proposed financial trading site is through many levels of the concept (Boselli, Cesarini, Mercorio, & Mezzanzanica, 2015; Rana, Dwivedi, Williams, & Weerakkody, 2015). Including system quality, user satisfaction, system usage, communication quality, service quality and net benefit (Delone & McLean, 2003; Rana et al., 2015). Recently, users use the "web cloud computing service"(Garrison, Wakefield, & Kim, 2015) aware of the network security measures are not tight will cause loss or adverse consequences (Forsey & Shi, 2003; Teneyuca, 2011). In order to prevent the insecurity of online transactions (Hong & Cha, 2013), set the secure socket layer (SSL) security credentials encryption mechanism (Manakshe, Jirkar, Wakhare, & Buram, 2014). So that third-party financial electronic payment agencies to access network consumer transactions to get better protection (Murdoch & Anderson, 2014). That is the safety of quality (Merkow & Breithaupt, 2014). The measure of communication quality includes the correctness of the information (Wang, Hahn, & Sutrave, 2016). Service quality is a measure of service consumer trust, user satisfaction, service reliability (Delone & McLean, 2003; Xu, Benbasat, & Cenfetelli, 2013). System quality measures ease of use and responsiveness (Koulayev et al., 2016; Zhou, 2013). Safety quality is the safety of the measurement system and the security of the transaction and the security of the network (Zheng, Zhao, & Stylianou, 2013). Communication quality is defined as the ability to quickly feedback users using system information (Heath, 2014). Service quality is defined as the user can easily operate the system (Zhou, 2013). System quality is defined as accessibility and increased user convenience (Zhou, 2014), to improve support for the system (Sabherwal, Jeyaraj, & Chowa, 2006). In addition, based on financial electronic payment under the key factors, system quality, communication quality, service quality and safety quality, will affect the consumer and consumer’s satisfaction (Fang et al., 2014; Sabherwal et al., 2006). Therefore, the system quality, communication quality, service quality and safety quality will be the key factors that affect the quality of financial electronic payment (Ming-Yen Teoh, Choy Chong, Lin, & Wei Chua, 2013). And then assess the importance of the payment system (Liébana-Cabanillas, Sánchez-Fernández, & Muñoz-Leiva, 2014).

A certain level of elements, with its level of the elements as an assessment benchmark, perform a pairwise comparison between the hierarchy elements (Schmoldt, Kangas, Mendoza, & Pesonen, 2013), and the comparison between the various elements (Macharis, Springael, De Brucker, & Verbeke, 2004). The basic assessment scale used for hierarchical analysis is defined by verbal judgments ranking (Aminbakhsh, Gunduz, & Sonmez, 2013; Hummel, Bridges, & IJzerman, 2014), Including "equally important", "slightly important", "quite important", "extremely important" and "absolutely important". Corresponding to the resulting numerical scale (numerical judgments) for (1,3,5,7,9), and the trade-off values (2, 4, 6, 8). The meaning and description of each scale are shown in Table 1:

<table>
<thead>
<tr>
<th>Evaluation scale</th>
<th>Definition</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 or (1: 1)</td>
<td>Equally important</td>
<td>The two elements are of the same importance</td>
</tr>
<tr>
<td>3 or (3: 1)</td>
<td>Slightly important</td>
<td>Experience to judge a little tendency to like a certain factor</td>
</tr>
<tr>
<td>5 or (5: 1)</td>
<td>Quite important</td>
<td>Experience judgment tends to prefer a factor</td>
</tr>
<tr>
<td>7 or (7: 1)</td>
<td>Very important</td>
<td>The actual display is very strongly inclined to like a certain factor</td>
</tr>
<tr>
<td>9 or (9: 1)</td>
<td>Absolutely important</td>
<td>Sufficient evidence certainly definitely likes an element</td>
</tr>
<tr>
<td>2, 4, 6, 8</td>
<td>Adjacent scale</td>
<td>Need to compromise</td>
</tr>
</tbody>
</table>

The selection of the scale is depending on the actual situation (Meade & Presley, 2002). But not more than nine scales for the principle (Satty, 2004). Otherwise it will cause the burden of the judgments (Satty, 2004). A pairwise comparison matrix A is obtained by pairwise comparing the two factors. Due to pairs of reciprocal nature, if the ratio of the factor i to j is α<sub>ij</sub>, the ratio of the element i to the element j is the reciprocal of the original ratio, that is, 1 / α<sub>ij</sub>. Similarly, the lower triangular part of the pairing comparison matrix A is the reciprocal of the upper triangular part.

And in the questionnaire, for each sub-criteria attribute design, to compare the way in the 1-9 scale to the decision-makers and experts in various fields to fill. According to the results obtained from the questionnaire, will be able to establish the level of the pair of comparison matrix A:

\[
[A] = [\alpha] = \begin{bmatrix}
1 & \alpha_{12} & \cdots & \alpha_{1n} \\
1/\alpha_{12} & 1 & \cdots & \alpha_{2n} \\
\vdots & \vdots & \ddots & \vdots \\
1/\alpha_{1n} & 1/\alpha_{2n} & \cdots & 1
\end{bmatrix}
\]
After the pairwise comparison matrix \( [a_{ij}] \) is established, the weight \( [w_{ij}] \) of each element can be obtained. Using the eigenvalue method commonly used in numerical analysis, the eigenvector or the dominant vector is calculated, and the relative weight between the elements is obtained. The calculation process will be described as follows:

Making sub-criteria pairs of comparison matrix \( A \), such as (1):

\[
A = \begin{bmatrix}
    a_{11} & a_{12} & \cdots & a_{1n} \\
    a_{21} & a_{22} & \cdots & a_{2n} \\
    \vdots & \vdots & \ddots & \vdots \\
    a_{n1} & a_{n2} & \cdots & a_{nn}
\end{bmatrix}
\]

Where \( a_{ij} = w_i / w_j \) is the weight of sub-criteria \( i \) and \( j \). The pairwise comparison matrix \( A \) is a positive and negative matrix, and the elements in the matrix are positive and the reciprocal characteristics are as follows: (2) and (3):

\[
a_{ij} = 1 / a_{ji} \\
a_{ij} = a_{ik} / a_{jk}
\]

The vector of the sub-criterion pairs \( A \) is multiplied by the weight of each criterion as shown in (4):

\[
\vec{w} = (w_1, w_2, \cdots, w_n)
\]

Then obtained (5) and (6):

\[
A\vec{w} = \begin{bmatrix}
    w_1 / w_1 & w_1 / w_2 & \cdots & w_1 / w_n \\
    w_2 / w_1 & w_2 / w_2 & \cdots & w_2 / w_n \\
    \vdots & \vdots & \ddots & \vdots \\
    w_n / w_1 & w_n / w_2 & \cdots & w_n / w_n
\end{bmatrix}
\]

\[
\begin{bmatrix}
    w_1 \\
    w_2 \\
    \vdots \\
    w_n
\end{bmatrix}
\]

\[
(A-n)\vec{w} = 0
\]

Because \( a_{ij} \) is the decision maker to compare the subjective judgment given by the comparison, with the real \( w/w_j \) value, there must be a certain degree of difference, so \( A\vec{w} = n \vec{w} \) cannot be established. Thus, Saaty suggests replacing \( n \) with the largest eigenvalue \( \lambda_{\text{max}} \) in the \( A \) matrix.

That is \( AW = \lambda_{\text{max}}W \) \hspace{1cm} (8)

\[
(A - \lambda_{\text{max}}I)W = 0
\]

The maximum eigenvalue of matrix \( A \) is calculated by (9), and the maximum eigenvector is the weight of each criterion. And the maximum eigenvalue of the calculation, Saaty proposed four approximation method, which in turn the normal value of the row vector method (10) can be obtained more accurate results.
$$w_j = \frac{1}{n} \sum_{j=1}^{n} a_{ij} \sum_{i=1}^{n} a_{ij}$$  \quad i, j = 1, 2, \ldots, n$$

(10)

In order to confirm that the decision maker can achieve consistency before and after comparison, it is necessary to carry out the consistency test, make the consistency index (CI) and the consistency ratio (CR). Check according to the decision maker, the answer to the composition of the pair of comparison matrix is consistent matrix.

The main function and purpose of the consistency indicator is to determine whether the decision maker has made a reasonable judgment in the process of decision comparison. Whether it is consistent or whether there is any contradiction, etc., in order to correct the decision to avoid making bad decisions. Resulting in weight between the elements, the calculation produces an irrational phenomenon.

Consistency verification can also be used for the entire hierarchy, because the importance of each level is different, so to test whether the entire hierarchy is consistent. Therefore, Saaty (1980) suggested that when C.I. ≤ 0.2 is also acceptable error, the test formula (11)

$$C.I. = \frac{\lambda_{\text{max}} - n}{n - 1}$$

(11)

Where n: evaluates the number of sub-criteria, $\lambda_{\text{max}}$ is the largest eigenvalue of matrix A. If $\lambda_{\text{max}} = n$, then the pairwise comparison matrix A has consistency. When C.I. = 0, that before and after the judge is completely consistent; and C.I. > 0, it means that before and after the error is not consistent; C.I. < 0, said before and after the judge is not consistent, but still within the acceptable range.

However, when the problem becomes more complex, the elements to be compared will become more, and the order of the pairs of matrices will increase, so it will be more difficult to maintain consistency. Satty also proposes a Random Index (RI) to adjust the CI values of varying degrees to different levels. The resulting value is the Consistency Ratio (CR). If CR ≤ 0.1, then the degree of agreement of the matrix is satisfactory, which means that the pair of scales have a certain degree of "reliability", see Table 2. The formula is as follows:

$$C.R. = \frac{C.I.}{R.I.}$$

(12)

<table>
<thead>
<tr>
<th>Consistency index (C.I.)</th>
<th>C.I. = $\frac{\lambda_{\text{max}} - n}{n - 1}$</th>
<th>C.I. &gt; 0, said before and after the judge inconsistency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consistency ratio (C.R.)</td>
<td>$C.R. = \frac{C.I.}{R.I.}$, Which R.I. value to look up the table</td>
<td>C.I. = 0, said before and after the judge completely consistent</td>
</tr>
<tr>
<td></td>
<td>C.R. ≤ 0.1, indicating an allowable deviation</td>
<td>C.R. ≤ 0.1, Indicating consistency to an acceptable level</td>
</tr>
</tbody>
</table>

The pairwise comparison matrix can be followed by the order number n to correspond to the random index (R. I.), as shown in Table 3:
Table 3: Random Indicator Table

<table>
<thead>
<tr>
<th>Order</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>R.I.</td>
<td>0.00</td>
<td>0.00</td>
<td>0.58</td>
<td>0.9</td>
<td>1.12</td>
<td>1.24</td>
<td>1.32</td>
<td>1.41</td>
</tr>
<tr>
<td>Order</td>
<td>9</td>
<td>10</td>
<td>11</td>
<td>12</td>
<td>13</td>
<td>14</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>R.I.</td>
<td>1.45</td>
<td>1.49</td>
<td>1.51</td>
<td>1.48</td>
<td>1.56</td>
<td>1.57</td>
<td>1.58</td>
<td></td>
</tr>
</tbody>
</table>

The weight of each criterion, multiplied by the performance of the program, the resulting product is the overall performance of the program, and finally the overall performance of the program sort, you can get the priority of the program, that is, clearly know each the importance of the element to the ultimate goal as a basis for decision making or assessment. Fundamentally, the main and sub-criteria are as shown in Tab. 4 and Tab. 5.

Table 4: Definition of primary and secondary criteria for the quality of financial electronic payment system

<table>
<thead>
<tr>
<th>Main criteria</th>
<th>definition</th>
<th>The source of the literature</th>
</tr>
</thead>
<tbody>
<tr>
<td>System quality</td>
<td>Evaluation of the information system itself, which includes ease of operation, time response, easy-to-use functions, flexibility of the system, ease of use, ease of access, ease of learning, and the degree of user's needs. System characteristics, systems Precision, system reliability, system integration, system correctness, system efficiency, resource usage, response time and system response time.</td>
<td>(Delone &amp; McLean, 2003)</td>
</tr>
<tr>
<td>Communication quality</td>
<td>The evaluation of the output of the communication system, including the correctness, completeness, timeliness, relevance, liquidity, clarity, comprehensibility, usefulness, reliability, up-to-date, objectivity and streamlining of the output data.</td>
<td>(Delone &amp; McLean, 2003)</td>
</tr>
<tr>
<td>Service quality</td>
<td>Service quality, behavioral intention and financial performance. It is found that the quality of service will have a positive correlation with the intention of behavior. When the service quality is good, the behavior intention is the strongest, and the behavior intention will have an impact on the customer's behavior, and then the customer behavior will have an impact on the company's financial performance.</td>
<td>(Zeithaml, Berry, &amp; Parasuraman, 1996)</td>
</tr>
<tr>
<td>Safety quality</td>
<td>When using the Internet Cloud Computing Service, the user is aware that if the network security is not tight, it will cause loss or adverse consequences.</td>
<td>(Jacoby &amp; Kaplan, 1972); (Moore &amp; Benbasat, 1991); (Heyen, Kasiraj, &amp; Wolf, 1992)</td>
</tr>
</tbody>
</table>

Table 5: Definition of Quality Criteria for Financial Electronic Payment System

<table>
<thead>
<tr>
<th>Sub-criteria</th>
<th>Definition</th>
<th>The source of the literature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ease of use</td>
<td>Making it easier for users to get started.</td>
<td>(Benbasat, Cenfetelli, &amp; Tan, 2007; L.-d. Chen, 2008)</td>
</tr>
<tr>
<td>Response speed</td>
<td>Users can make any requests for online transactions, and the site can quickly meet learners.</td>
<td>(Woldie, Hinson, Iddrisu, &amp; Boateng,</td>
</tr>
</tbody>
</table>
The basic idea of the method is based on the use of Euclidean distance to evaluate the ideal solution and negative ideal (S.-M. Chen & Lee, 2010). The distance between the solutions and the relative proximity is used as the sort of the selection scheme. The distance principle is used to express the distance between the alternatives and the ideal solution. The result is high and the result is an effective way to solve the problem. In a limited program, evaluation, sorting based on decision attributes (Abo-Sinna & Amer, 2005).

Real-world problems, many of the projects are usually multi-criteria decision making (MCDM), and these programs are mutually exclusive, non-quantitative conditions, then multi-criteria decision-making method is used to deal with the real world (Ondrus, Lyytinen, & Pigneur, 2009; Tsai, Chou, & Leu, 2011). In the same scale and mutually exclusive conditions, and no one program can meet all the conditions to make it the best solution (Linck, Poustchi, & Wiedemann, 2006). In this situation, the ideal solution to the optimal solution (TOPSIS) is particularly useful for dealing with such problems. (Masudin & Saputro, 2016).

The positive ideal solution (PIS) and negative ideal solution (NIS) are defined first in the evaluation process. The so-called ideal solution is the evaluation of the benefits of the program attributes of the largest value of the cost of the property of the assessment of the smallest value; On the other hand, the negative ideal solution is the minimum value of the alternatives, and the cost criterion is the largest. In the choice of the program, the distance between the ideal solution recently, the distance from the ideal solution is the best solution for the best solution.

From the previous studies, show that the ideal solution similarity preference order assessment method is a useful method to solve the best selection of the program (S. Chen, Li, & Tang, 2012; Ha, 2014). In addition, the preference order assessment method first uses the geometric mean calculation to integrate the opinions of many people, the basic idea can be explained in Figure 1. In the figure, two evaluation criteria C1 and C2 are used to explain, S is the sample space of n schemes, N is the negative ideal solution, and P is the ideal solution. When the A1 scheme is compared with the A2 scheme, the distance
between the A2 scheme and the ideal solution P is higher than that of the A1 scheme \((S_{2+} < S_{1+})\). While the A2 solution to the negative ideal solution N distance than the A1 program far \((S_{2-} > S_{1-})\). So A2 program better than A1 program, see figure 2.

**RESEARCH DESIGN**

The hierarchical analysis is a set of decision-making methods (Saaty, 1990) developed by Saaty (1977). In the case of contingency planning for the US Department of Defense, which is mainly used in the case of uncertainty and decision-making issues with multiple evaluation sub-criteria, the complexity of the problem one by one simplified (Asokan, Janson, Steiner, & Waidner, 1997). The theory of hierarchical analysis is simple and practical (Kadambi, Li, & Karp, 2009). As a result, since its inception, it has been used in priority order decisions, planning resources, allocations, forecasts and portfolios (A. S. Fisher & Kaplan, 2000). As the theory of hierarchical analysis is clear and simple, easy to operate, and can accommodate a number of experts and decision-making advice, widely used by academics and practitioners, the scope of its application is quite extensive (Bhushan & Rai, 2007).

When using hierarchical analysis, the target problem must be described first, and then the possible influencing factors can be identified and the hierarchical structure (Lee & Kozar, 2006). Using the two factors into pairs to compare the advantages and disadvantages between the two factors, and thus the establishment of pairs of comparison matrix, the use of matrix eigenvalues and eigenvector calculation, obtained the weight of each attribute and the program. And finally through the comprehensive evaluation of the way to obtain the best program sort (Neofytides & Baig, 2009). In order to confirm that the decision maker is able to achieve consistency before and after making the comparison, it is necessary to carry out the consistency test. To check whether the pairwise comparison matrices formed by the answers answered by the decision maker are consistent matrices, Saaty (1980) suggests that when \(CI \leq 0.1\), the best acceptable error, if \(CI \leq 0.2\), is also acceptable error.

This study evaluates the research framework of the sub-criteria of the financial electronic payment system, based on the successful model of the information system proposed by DeLon and McLean (2003), and develops the main criteria for evaluating the online financial electronic payment system through the relevant literature (Tajuddin, 2015). The first layer is the system quality, information quality, service quality and net benefit of the four parts of the study will be net benefits into safety quality, each part of the subdivision down, and its overall distinction is divided into three levels, such as Figure 2 shows.
TOPSIS calculus is to first define the ideal solution (PIS) and negative ideal solution (NIS) (Mahmoodzadeh, Shahrabi, Pariazar, & Zaeri, 2007). Its purpose is to find the distance from the "ideal solution" the closest distance, and from the "negative ideal solution" farthest away from the program. The so-called ideal solution refers to the alternative method, the benefit of the largest surface or the smallest cost of the sub-standard value; negative ideal solution is the smallest benefit or cost of the largest sub-standard value. The TOPSIS proposed by Hwang and Yoon is the best solution for finding the nearest distance to the "positive ideal solution (PIS) and the distance from the" ideal solution " (Yoon & Hwang, 1995). It can be used for different problems, in the calculation of the program's PIS and NIS the best distance (Lai, Liu, & Hwang, 1994). According to the development of Minkowski's Lp metric, for different issues using different distance calculation, the calculation steps such as columns:

The decision-making problem m alternatives, n evaluation sub-criteria, converted into matrix \( \mathbf{x} \), that is \( x_{ij} \) has been presented the order of the relationship between the various programs

(A). \( (x_{ij})_{m \times n} \).

(B). Let the original matrix \( (x_{ij})_{m \times n} \) Normalized to \( \mathbf{R} = (r_{ij})_{m \times n} \)

which is \( r_{ij} = \frac{x_{ij}}{\sum_{j=1}^{n}x_{ij}} \), \( i = 1,2,\ldots,m;\, j = 1,2,\ldots,n \)

(C). Determine the weight, after the experts specify the weight \( w_j \)

The establishment of weighted decision matrix \( \mathbf{\tau} = (r_{ij})_{m \times n} \), among them \( \sum_{j=1}^{n}w_j = 1 \) \( w_j \) for the j sub-criteria.

(D). to determine the worst choice \( \mathbf{A_w} \) and the best choice \( \mathbf{A_b} \)

\[ \mathbf{A_w} = \{(\max(t_{ij})|i=1,2,\ldots,m)|j \in J_+, \{(\min(t_{ij})|i=1,2,\ldots,m)|j \in J_+\}\] \[ \mathbf{A_b} = \{(\min(t_{ij})|i=1,2,\ldots,m)|j \in J_-, \{(\max(t_{ij})|i=1,2,\ldots,m)|j \in J_-\}\] among them \( J_+ = \{j = 1,2,\ldots,n\} \) associated with standards that have a positive impact \( J_- = \{j = 1,2,\ldots,n\} \) associated with standards that have a negative impact.

(E). Calculate the separation measure \( d_{bw} \) and \( d_{ib} \)

\[ d_{bw} = \sqrt{\sum_{i=1}^{n}(t_{ij} - n_{ij})^2}, i = 1,2,\ldots,m, \]
In this study, we focus on scholars who are engaged in electronic payment related research and industry, those who frequently use financial electronic payment. Respondents showed a total number of 15 e-payment experts. The questionnaire was issued a total of 15, recycling 15 questionnaires. Table 6 shows the demographic of the respondents.

Table 6: Demographics of the respondents

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Frequency</th>
<th>Percent (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>13</td>
<td>86.6%</td>
</tr>
<tr>
<td>Female</td>
<td>2</td>
<td>13.4%</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20-29</td>
<td>6</td>
<td>40.0%</td>
</tr>
<tr>
<td>30-39</td>
<td>3</td>
<td>20.0%</td>
</tr>
<tr>
<td>&gt;=40</td>
<td>6</td>
<td>40.0%</td>
</tr>
<tr>
<td>Education level</td>
<td></td>
<td></td>
</tr>
<tr>
<td>College</td>
<td>5</td>
<td>33.3%</td>
</tr>
<tr>
<td>Graduate</td>
<td>10</td>
<td>66.7%</td>
</tr>
<tr>
<td>Occupation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Business</td>
<td>2</td>
<td>13.3%</td>
</tr>
<tr>
<td>Information</td>
<td>5</td>
<td>33.3%</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>1</td>
<td>6.66%</td>
</tr>
<tr>
<td>Service</td>
<td>1</td>
<td>6.66%</td>
</tr>
<tr>
<td>Self-employed</td>
<td>2</td>
<td>13.3%</td>
</tr>
<tr>
<td>Student</td>
<td>3</td>
<td>20.0%</td>
</tr>
<tr>
<td>Others</td>
<td>1</td>
<td>6.66%</td>
</tr>
<tr>
<td>Professional license</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>13</td>
<td>86.6%</td>
</tr>
<tr>
<td>No</td>
<td>2</td>
<td>13.4%</td>
</tr>
<tr>
<td>Working years</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than five years</td>
<td>3</td>
<td>20.0%</td>
</tr>
<tr>
<td>More than five years, less than ten years</td>
<td>3</td>
<td>20.0%</td>
</tr>
<tr>
<td>More than a decade</td>
<td>8</td>
<td>60.0%</td>
</tr>
</tbody>
</table>

DATA ANALYSIS

Based on the hierarchical structure analysis and questionnaire data, the evaluation structure of the financial electronic payment system quality is constructed. The weight of the main and sub-criteria is developed, and the preference order of the sub-criteria is evaluated by TOPSIS. Then the key success factors of electronic payment quality are discussed. The analysis steps are listed below.

Hierarchical Analysis e-Payment System

First perform a consistency check. Using the Choice Maker software for operation analysis, the Consistency Ratio (CR) must be less than 0.1 to meet the logical consistency requirements. Through the consistency test, the weight value obtained by it is meaningful. The CR values of the overall level presented in Table 6 are less than 0.1, indicating that the overall hierarchy is consistent, and that the weight of each criterion is calculated and evaluated by information compiled by 10 experts and 5-bit system users are available. Table 7 shows the consistency ratio for each level.
Table 7: CR values for each level

| Network security, system security, transaction security (sub-criteria) | 0.000250 | 0.0005~0.0008 |

Continue to process the questionnaire data from 10 experts and 5 system users. Find the overall level and the first layer, the second layer of the main, sub-criteria. In addition, the overall level of view, the first assessment criteria for the 11 assessment sub-criteria, which were most subject to expert and attention, were in the order of transaction safety (10.22%). On behalf of the data in the system within the process, should ensure the safety of information. Ease of use (7.77%), meaning the convenience of the user for financial electronic payment systems. Response speed (7.22%), refers to the other side of the response speed. System security (5.98%), refers to the privacy of the network security, the use of e-mail security, network community communication security. Trust (5.22%), which is based on the user's positive expectations, is willing to accept the online system pipeline provided by the online interaction.

The above criteria, ease of use and response speed are the criteria for the evaluation of the quality of the main criteria. System security and network security belong to the safety quality of the assessment criteria. Trust is the quality of service. It can be seen that the higher the relative importance of the sub-criteria, the higher the importance of the main criteria. In addition, the importance of the 11 evaluation sub-criteria, the quality of the system and the quality of the bottom of the sub-criteria have a high proportion, so users and experts believe that the quality of security and system quality is the impact of electronic financial payment system quality Key factors. Table 8 shows the overall level assessment of the main and sub-criteria weight values and sorting.

Table 8: Overall level assessment of the main and sub-criteria weight values and sorting

<table>
<thead>
<tr>
<th>Aims</th>
<th>Main-criteria</th>
<th>Sub-criteria</th>
<th>Sub-criteria weight</th>
<th>Complex weight</th>
<th>Sorting</th>
</tr>
</thead>
<tbody>
<tr>
<td>System quality (24.49%)</td>
<td>System</td>
<td>Quality</td>
<td>Ease of use</td>
<td>40.82%</td>
<td>7.77%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Response speed</td>
<td>22.79%</td>
<td>7.22%</td>
</tr>
<tr>
<td>Information quality (23.18%)</td>
<td>Service</td>
<td>Quality</td>
<td>Accuracy</td>
<td>20.47%</td>
<td>4.82%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Immediate</td>
<td>22.90%</td>
<td>4.19%</td>
</tr>
<tr>
<td>Electronic Payment System (20.07%)</td>
<td>Safety</td>
<td>Quality</td>
<td>Integrity</td>
<td>27.62%</td>
<td>4.05%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Trust</td>
<td>28.15%</td>
<td>5.28%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>User satisfaction</td>
<td>18.05%</td>
<td>2.68%</td>
</tr>
<tr>
<td>Safety quality (32.26%)</td>
<td></td>
<td>System security</td>
<td>Network security</td>
<td>37.93%</td>
<td>5.02%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>system security</td>
<td>20.61%</td>
<td>5.98%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Safety of trademend</td>
<td>53.73%</td>
<td>10.22%</td>
</tr>
</tbody>
</table>

From the establishment of the four main criteria, 11 sub-criteria of the financial electronic payment system priority factors priority, From the establishment of the four main criteria, 11 sub-criteria of the financial electronic payment system priority factors priority, as a program for the selection of electronic payment system. By the various factors given to the priority value of the three programs point of view, the weight of each part is not the same.

According to the comprehensive value of each criterion, it is found that the financial electronic payment system scheme is the third party payment, the third is the Internet bank, the action payment is slightly less favored by the users and experts. Table 9 Shown the impact of financial electronic payment of key factors in the selection of the overall priorities and complex weight value.

Table 9: Weight of the financial electronic payment system

<table>
<thead>
<tr>
<th>Sub-criteria</th>
<th>Complex weight</th>
<th>Internet banking</th>
<th>Mobile payment</th>
<th>Third party payment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ease of use</td>
<td>0.078</td>
<td>90</td>
<td>89</td>
<td>93</td>
</tr>
<tr>
<td>Response speed</td>
<td>0.072</td>
<td>90</td>
<td>90</td>
<td>89</td>
</tr>
<tr>
<td>Accuracy</td>
<td>0.048</td>
<td>88</td>
<td>87</td>
<td>91</td>
</tr>
<tr>
<td>Immediate</td>
<td>0.042</td>
<td>90</td>
<td>89</td>
<td>90</td>
</tr>
<tr>
<td>Integrity</td>
<td>0.041</td>
<td>91</td>
<td>90</td>
<td>93</td>
</tr>
<tr>
<td>Reliability</td>
<td>0.027</td>
<td>93</td>
<td>89</td>
<td>93</td>
</tr>
<tr>
<td>Trust</td>
<td>0.053</td>
<td>90</td>
<td>88</td>
<td>91</td>
</tr>
<tr>
<td>User satisfaction</td>
<td>0.027</td>
<td>89</td>
<td>89</td>
<td>93</td>
</tr>
<tr>
<td>Network security</td>
<td>0.050</td>
<td>91</td>
<td>90</td>
<td>94</td>
</tr>
</tbody>
</table>
The TOPSIS method to use the final ranking of the advantages, the main reason is that this method is suitable for the theme of this study, in practice is not difficult and easy to understand. TOPSIS requires two basic prerequisites, the weight of the attribute is known, the monotonically increasing or monotonically decreasing property (Garg & Narahari, 2009). Just for the operation of financial electronic payment system quality of the key factors have the characteristics. Thus, the decision matrix after normalization of the vector is obtained via the preceding steps, as shown in Table 10.

Table 10: Decision Matrix for Financial e-Payment System Guidelines

<table>
<thead>
<tr>
<th>Program / main criteria</th>
<th>System quality</th>
<th>Communication quality</th>
<th>Service quality</th>
<th>Safety quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internet banking</td>
<td>0.2441</td>
<td>0.2051</td>
<td>0.2053</td>
<td>0.3453</td>
</tr>
<tr>
<td>Mobile payment</td>
<td>0.2641</td>
<td>0.2083</td>
<td>0.20513</td>
<td>0.3423</td>
</tr>
<tr>
<td>Third party payment</td>
<td>0.2782</td>
<td>0.2086</td>
<td>0.2181</td>
<td>0.2951</td>
</tr>
<tr>
<td>weights</td>
<td>0.2585</td>
<td>0.2441</td>
<td>0.2331</td>
<td>0.2643</td>
</tr>
<tr>
<td>the ideal</td>
<td>0.2653</td>
<td>0.2370</td>
<td>0.2137</td>
<td>0.2840</td>
</tr>
<tr>
<td>the worst</td>
<td>0.2482</td>
<td>0.2552</td>
<td>0.2651</td>
<td>0.2315</td>
</tr>
</tbody>
</table>

Go to the next step in the TOPSIS method is to determine the positive ideal solution (PIS) and the negative ideal solution (NIS). And calculate the distance between the solution and the ideal solution and the negative ideal solution, so that the scheme to be selected is the closest to the ideal solution, and the distance from the negative ideal solution farthest. Therefore, the ideal solution and the negative ideal solution are calculated for each criterion, as shown in Table 11 and Table 12.

Table 11: Ideal solution for the quality of financial e-payment systems

<table>
<thead>
<tr>
<th>Program / main criteria</th>
<th>System quality</th>
<th>Communication quality</th>
<th>Service quality</th>
<th>Safety quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internet banking</td>
<td>0.0982</td>
<td>0.1204</td>
<td>0.0652</td>
<td>0.1868</td>
</tr>
<tr>
<td>Mobile payment</td>
<td>0.0504</td>
<td>0.1140</td>
<td>0.0452</td>
<td>0.1258</td>
</tr>
<tr>
<td>Third party payment</td>
<td>0.1686</td>
<td>0.1340</td>
<td>0.0852</td>
<td>0.2172</td>
</tr>
</tbody>
</table>

And then seek their distance with the ideal solution (S+) and the distance of the ideal solution (S-). Calculate the separation measure for each scheme from the ideal solution (di+) and the separation measure of the negative ideal solution (di-). And obtain the relative degree of closeness (Ci) of each scheme to the ideal solution, it can be sorted according to the size of this value, and the financial electronic payment system scheme is close to the ideal solution, as shown in Table 13.

Table 13: Relative proximity of financial e-payment ideal solutions

<table>
<thead>
<tr>
<th>Program</th>
<th>di+</th>
<th>di-</th>
<th>Ci (Proximity)</th>
<th>result - rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internet banking</td>
<td>0.2118</td>
<td>0.2832</td>
<td>0.5721</td>
<td>2</td>
</tr>
</tbody>
</table>
The aim of this paper is to develop a hierarchy framework in assessing the key success factors of the quality of financial electronic payment systems. Compare the relative weight values with AHP in TOPSIS, it is clearly understand the impact of the guidelines, and further provide a gradual increase in the use of electronic payment system. Also it is an important reference and substantive recommendations to the financial electronic payment providers.

In addition, the users and experts agree that the safety quality should be considered as the first consideration for the quality of the financial electronic payment system, and its weight value (32.26%) accounts for a very high proportion. Therefore, the security quality of the underlying level of the two criteria included in the overall level of ranking, accounting for the top six, namely, transaction security and network security.

Furthermore, the system quality of the underlying level included in the ease of use and response speed, the overall level of ranking is the top three. And in the quality of information and service quality, which contains the underlying criteria is biased towards the technical aspects of the system and service level. The results show that the weight values of the two and its underlying criteria are relatively low, but they are still necessary to evaluate the sub-criteria. This phenomenon represents the user's electronic payment behavior first to pay attention to security, and then consider the ease of payment operations.

However, the results of the study found that each evaluation sub-criteria have its importance, but users and experts believe that the financial quality of electronic payment and system quality should be emphasized and attention, and the transaction is easy and easy to operate. Users are critical of the use of the system and are satisfied.

**Conclusion**

The aim of this paper is to develop a hierarchy framework in assessing the key success factors of the quality of financial electronic payment systems. Compare the relative weight values with AHP in TOPSIS, it is clearly understand the impact of the guidelines, and further provide a gradual increase in the use of electronic payment system. Also it is an important reference and substantive recommendations to the financial electronic payment providers.

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However, the results of the study found that each evaluation sub-criteria have its importance, but users and experts believe that the financial quality of electronic payment and system quality should be emphasized and attention, and the transaction is easy and easy to operate. Users are critical of the use of the system and are satisfied.

**Suggestion**

Review the financial electronic payment system quality assessment results, for the future development of electronic trading environment, the researchers made a number of reminds and recommendations. The first user level, a comprehensive assessment of the results of the guidelines, the majority of users for the transaction security, ease of use and response speed requirements may be due to work or mission requirements, the required level of quality differently.

The hierarchical structure and assessment of the criteria, the establishment of the assessment model, not only to provide a general electronic payment system and the main functional reference, and financial electronic payment system suppliers will be different with the needs of users, the relevant assessment criteria can also be for the reference, the evaluation results for the system provider can provide substantive advice.

The development of financial electronic payment market will be more and more vigorous. If the specific areas of electronic payment assessment should be based on the objectives of the field, the project and the scope of a detailed consideration, the assessment model will be more in line with specific needs. Researchers can refer to the evaluation model of this study, on the one hand to improve the degree of discrimination, on the other hand to accurately assess the true characteristics of the field for more valuable research. Future study may change survey type from cross-sectional to longitudinal. For example, time series or panel data analysis.

**References**


[26] Heath, S. (2014). System and method for using global location information, 2D and 3D mapping, social media, and user behavior and information for a consumer feedback social media analytics platform for providing analytic measurements data of online consumer feedback for global brand products or services of past, present or future customers, users, and/or target markets. U.S. Patent No. 8,909,771. Washington, DC: U.S. Patent and Trademark Office.


