Studies on Fuzzy Comprehensive Evaluation of Trust Information System

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Abstract — Evaluation of an information system’s success and user satisfaction are important issues in information systems research, especially for emerging online service systems on the Internet. The purpose of this study is to develop an evaluation model for question investigation from user’s perspective. We have established the theoretical foundation and conceptualization of the constructs for user satisfaction question investigation. This paper is posing the problem of how we should evaluate the reputation of information system, taking the practical conditions in China’s enterprise information system (CEIS). It’s also discussing the domain of information system reputation, the method for establishing dependent functions for the evaluation of information system. And the author has founded a direct method for the recognition of many factors, which is valuable in practical application.

Index Terms — Information system; membership functions for reputation; comprehensive evaluation; relative membership model

I. INTRODUCTION

Evaluation of an information system’s success and user satisfaction are important research issues in the field of information management, especially for online service systems on the Internet. Evaluation models are used to understand user’s needs and identify important dimensions and factors in the development of information systems in order to broaden their acceptance. With the rapid growth of the Internet and database technologies in recent years, the evaluation of Trust Information Systems (TIS) have emerged as important applications [1-5]. Hence, they have received a great deal of attention from information systems researchers, particularly those in the information retrieval and natural language processing communities.

TIS is an abstract from the practical conditions, and the comprehensive evaluation of the user’s of information systems. It has become a skill, which must be grasped by the organizations, to employ subsequently qualitative and quantitative analysis to make a plan or decision according to the variations of its reputation, and to determine its qualities and the inside relationship between its trusted degree. Quantitative analysis is to discuss the inner commotion between the trusted degree of information systems and the qualities with mathematic methods, on the basis of qualitative analysis.

The purpose of this paper is to develop an effective fuzzy evaluation model for TIS based on research result of literature [1-8]. Based on the user’s investigation in the degree of satisfaction to information system, we propose a practical method for the design of TIS to make appraisal user satisfaction and acceptance. As most evaluation method focus on humanity-centered evaluation, practical-centered evaluation and security-centered evaluation has attracted little attention [5, 4]. However, if we are to build a practical RIS, we must achieve a performance level that satisfies the majority of users. Therefore, in this paper, we propose an integrated fuzzy comprehensive evaluation method of successful TIS from the user’s perspective. Our goal is to analysis two questions. (1) How do individual users evaluate the success of TIS? (2) What factors influence an individual user’s evaluation of a TIS success?

This paper is organized as follows: Section 2 provides a brief overview of the evaluation on TIS, setting the background for the present research, and shows the architecture of TIS in uncertainty category. Section 3 introduces the method of fuzzy comprehensive evaluation based on uncertainty category. Finally, Section 4 draws a conclusion and further work.

II. FUZZY COMPREHENSIVE EVALUATION OF TIS

A. The domain of Information Systems Reputation

Discussing domain refers to the scope and space of the studied object. As a proposition to be discussed, information systems may be considered as a discussing domain. Discussing the domain of TIS is made up of elements. The elements in the discussing domain of TIS are including the humanity of information systems (HIS), the practical of information systems (PIS), the technology service of information systems (TSIS) and the price of information system (software price) (SP). And, they are defined the quality of information systems (See figure 1).

The quality of information systems is the objective request of the quality or the product suitability, reliability, an economy of the information systems products.

![Figure 1 The structure of trust information systems](image-url)
It’s made up of two aspects: one is economic of product, and the other is technological of products. Information systems product’s price is the money representation of information systems value. TIS can be denoted by:

\[ U = \{ \text{humanity, practical, security, service and price} \} \]  (1)

They are the elements in the discussing domain of organizational reputation, each of which has area boundary in its own sense. The relationship between them and the TIS is fuzzy mathematically. TIS may be described in appraisal language “very satisfactory”, “both satisfactory and dissatisfactory”, “dissatisfactory”, which the appraisal language as the elements, an appraisal aggregation of an organization reputation is formed.

\[ V = \{ \text{very satisfactory, both satisfactory and dissatisfactory, satisfactory, dissatisfactory} \} \]  (2)

There is no clear limit between the elements of appraisal aggregation, and it is only a recognition that is resulted from common practice in the process of human thinking. The process and contents of human thinking is always represented in a certain way, which may be expressed quantitatively with modern algebra to an appropriate mathematical model. To appraise the elements information systems reputation domain with approbation, the degree of subordinate appraisal aggregation of product quality, service and product price must be determined. The membership function \( \mu (u) \) when information systems quality is “very satisfactory”, membership function \( \mu (u) \)  (Very satisfactory, \( u_1 \)) = 1, when information systems quality is “dissatisfactory”, membership functions \( \mu (Dissatisfactory, u_1) \) = 1.

Membership function represents the degree of the users’ appraisal of information systems quality, being any of the values between 0, 1. Humanity of information systems is subject to appraisal aggregation, the horizontal quantity formed by different membership function value is called the horizontal quantity of information systems, denoted as:

\[ R_1 = \{ \mu_1 (\text{very satisfactory, } u_1), \mu_1 (\text{satisfactory, } u_1), \mu_1 (\text{dissatisfactory, } u_1) \} \]  (3)

So it is with the horizontal quantity of membership function of PIS, denoted by expression (4) that of SIS by (5) that of PP by (6)

\[ R_2 = \{ \mu_2 (\text{very satisfactory, } u_2), \mu_2 (\text{satisfactory, } u_2), \mu_2 (\text{dissatisfactory, } u_2) \} \]  (4)

\[ R_3 = \{ \mu_3 (\text{very satisfactory, } u_3), \mu_3 (\text{satisfactory, } u_3), \mu_3 (\text{dissatisfactory, } u_3) \} \]  (5)

\[ R_4 = \{ \mu_4 (\text{very satisfactory, } u_4), \mu_4 (\text{satisfactory, } u_4), \mu_4 (\text{dissatisfactory, } u_4) \} \]  (6)

The determination of membership functions random appraisal of the information systems quality, the humanity of information system and the practical of software is not feasible. We may engage in study of the appraisal in the aspects of the subjective (internal factors) and the objective (user’s reflection).

B. The License of Information Systems

In the design of the information systems, an organization often considers quality as the target. It is first to design the information systems according to the request of the users and the specific standard of that of the state. According to the designed quality demand, the software of information system should be made both strict and homogenized. Influenced by the stability of the technological process, the homogenizing degree of the software quality is usually reflected by the grade ratio, which is divided into the ratios of the top quality, the first-rate, the qualified software and unqualified software. The high quality ratio is the percentage of the user’s satisfactory degree. So it is with other grades. How should we determine the membership function with clear logic? There is no rule for it at present. We but have to give the dependent functional mathematic model. If an organization has not got the design license of information system, then we have:

\[ \mu_1 (\text{dissatisfactory/license, } u_1) = 1 \]

\[ \mu_1 (\text{very satisfactory/license, } u_1) = \mu_1 (\text{satisfactory/license, } u_1) = \mu_1 (\text{both satisfactory and dissatisfactory, } u_1) = \mu_1 (\text{dissatisfactory, } u_1) = 0 \]

If got it, \( \mu_1 (\text{satisfactory/license, } u_1) = 1 \) If the higher office has not delivered it, we may regard the information system as having got it. When the ratio of high quality and the one of first–rate equals to \( u_1 \), the function of HIS is denoted by formula or expression (7)

\[ \mu_1 (\text{satisfactory, } u_1) = \mu_1 (\text{satisfactory / license, } u_1) \]

Then

\[ \mu_1 (\text{very satisfactory, } u_1) = \mu_1^2 (\text{satisfactory, } u_1) \]

\[ = 1 - \mu_1 (\text{satisfactory, } u_1) \]  (8)

\[ \mu_1 (\text{both satisfactory and dissatisfactory, } u_1) = \mu_1 (\text{dissatisfactory, } u_1) \]

If an information system \( u_1 = 0.7 \), then put \( u_1 \) into formula (7), and calculating (8), we may get the horizontal quantity of the quality membership function, \( R_1 = [0.57, 0.76, 0.24, 0.24] \), which can be normalized as
\[ R_1 = [0.32, 0.42, 0.13, 0.13]. \]  

### C. The Means of PIS

The information system with commodity so as to serve the information management construction, and the main economic norm, which represents to provide the information system with Humanity Service (HS), is the design process. If an information system cannot provide the software with commodity, you can’t begin to talk about information system service. The information system design is the essential condition that determines the recognition level of service object, to guarantee the interests of the user. The information system lowest risks have the veto power on the design of software. When the users’ satisfactory degree are equal to or smaller than the lowest level:

- \( \mu_2 \) (dissatisfactory, \( u_2 \)) = 1,
- \( \mu_2 \) (very satisfactory, \( u_2 \)) =\( \mu_2 \) (satisfactory, \( u_2 \)) = \( \mu_2 \) (both satisfactory and dissatisfactory, \( u_2 \)) = 0.

\( \mu_2 \) (satisfactory, \( u_2 \))

\[
\begin{align*}
\mu_2(u_2) &= \begin{cases} 
0 & u_2 \leq s_{\text{min}} \\
1 + \left( \frac{u_2 - s_{\text{min}} \times 100}{65} \right)^{-1.25} & u_2 > s_{\text{min}}
\end{cases}
\end{align*}
\]  

(10)

Only when the satisfactory degrees are larger than the lowest level, can the information system get high appraisal. The membership functional mathematic model of product service is expressed in formula (10).

In formula (10), \( s_{\text{min}} \) representing the lowest level, \( u_2 \) representing the level in the period when the information system reputation is discussed.

If the information system’s lowest PIS are 0.6 them into formula (10) and with the calculation method in (8), we may get the solution of the membership functional horizontal quantity of the product service, \( R_2 = [0.7, 0.84, 0.16, 0.26] \) which may be moralized as

\[ R_2 = [0.37, 0.45, 0.09, 0.09]. \]  

(11)

### D. Technological Service of Information System

All the services except for the product service are belonging to technological service, including “three guarantees” propaganda of product, market forecasting, and so on. In practice you may find out that the “three guarantees” of product, the ratios of carrying out contracts, and market forecasting are playing important roles in technological service. The “three guarantees” ratio of contracts carried out are the major outside technological service to the outside (the organization’s consumers); and the market forecast is the major inside service (to the sections in the organization).Given \( u_3 \) stands for the ratio of three guarantees realizing; the ratio of carrying out the contracts (the ratio of contracts completing); \( n/N \) for the ratio of the accuracy of the forecasting; \( N \) for the total number of the market forecasting. The dependent functional mathematic model is shown in formula (12).

\[
\begin{align*}
\mu(u_3) &= \begin{cases} 
0 & u_3 \leq 0.5 \\
\frac{n}{N} \cdot \left[ \theta + \left( \frac{u_3 \times 100 - 50}{6} \right)^{-1.25} \right] & u_3 \geq 0.5
\end{cases}
\end{align*}
\]  

(12)

If an organization has 19 items of “three guarantees”, which the users satisfied with 17 of item in a cycle, then \( u_3 = 0.89 \), the ratio of contracts completing is 100%; and in this cycle, if we make a forecast for 9 kinds of products, with 7 serving as guide to planning and decision-making then the accuracy \( n/N = 0.78 \). Put it into formula (12) and with the calculating method (8), and the solution to dependent functional horizontal quantity \( R_3 = [0.56, 0.75, 0.25, 0.25] \), normalized as

\[ R_3 = [0.31, 0.41, 0.14, 0.14]. \]  

(13)

### E. The Prices of Software Product

According to the demand of the reformation of the economic system in our country, an organization has the right to determine the prices within a certain scope set by the state or according supply and demand in the market. Any organizations have the critical cost in the profit and loss with \( q_0 \) denoting it. In order to increase the profit, an organization tries hard to deduce critical cost, forming the sale cost of the product, denoted by \( q_4 \). Only when \( q_0 - q_4 \) has a bigger value, can the prices of industrial products be competitive in the marker, can the organization have higher reputation. Then the membership functional mathematic model for product prices is denoted by formula (14).

\[
\begin{align*}
\mu(u_4) &= \begin{cases} 
0 & u_4 \geq q_0 \\
\left( \frac{q_0 - u_4 \times 100}{15} \right)^{-1.25} & u_4 < q_0
\end{cases}
\end{align*}
\]  

(14)

When \( q_0 = 19.5, u_4 = 15 \) and putting it in formula (14) and calculating with the method in (8), we may get the solution that the horizontal quantity of dependent functions \( R_4 = [0.4, 0.64, 0.26, 0.26] \) normalized as

\[ R_4 = [0.25, 0.41, 0.17, 0.17]. \]  

(15)

From above we may get:

\[ R_1 = \{\mu_1(\text{very satisfactory}, u_1), \mu_1(\text{satisfactory, } u_1), \mu_1(\text{both satisfactory and dissatisfactory}, u_1), \mu_1(\text{dissatisfactory, } u_1)\} = (0.32, 0.42, 0.13, 0.13) \]
\( R_2 = \{ \mu_2 (\text{very satisfactory, } u_2), \mu_2 (\text{satisfactory, } u_2), \mu_2 (\text{both satisfactory and dissatisfactory, } u_2), \mu_2 (\text{dissatisfactory, } u_2) \} = (0.37, 0.45, 0.09, 0.09) \)

\( R_3 = \{ \mu_3 (\text{very satisfactory, } u_3), \mu_3 (\text{satisfactory, } u_3), \mu_3 (\text{both satisfactory and dissatisfactory, } u_3), \mu_3 (\text{dissatisfactory, } u_3) \} = (0.31, 0.41, 0.14, 0.14) \)

\( R_4 = \{ \mu_4 (\text{very satisfactory, } u_4), \mu_4 (\text{satisfactory, } u_4), \mu_4 (\text{both satisfactory and dissatisfactory, } u_4), \mu_4 (\text{dissatisfactory, } u_4) \} = (0.25, 0.41, 0.17, 0.17) \)

III. CONCLUSION AND FUTURE RESEARCH

We have rigorously tested the TIS instrument and found that it provides a high degree of confidence in the reliability and validity of the scales. A comprehensive model for measuring RIS is presented. In this study, we developed fuzzy comprehensive evaluation (FSE) for measuring TIS. The four membership function of TIS is ease of use, usefulness, service quality, and content quality. To enhance user satisfaction and the success of information systems, we have developed an integrated theoretical evaluation model for such systems, based on a review and synthesis of existing IS user satisfaction and technology acceptance models. We believe the proposed evaluation model provides a framework for the design of information systems from the users’ perspective and that it could help increase user acceptance of information system.

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