

# A TRUST EVALUATION MODEL OF INTERNET BANKING CUSTOMERS

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**Keywords:** Internet banking, Trust, Trust degree, Trust evaluation model.

**Abstract:** It is a hot topics that how to measure the trust degree of the Internet banking customers. The major factors on impacting the customers' trust are their personal trust propensity and the recommendation trust before the customer uses it. But the customer's own experience is the major factor after they have used it. In this paper, we establish a two-stage Internet banking customer trust evaluation model. Using this model, the bank managers can measure the trust degree of the customers in the different periods. We hope the model can provide a strong support for the bank managers' decision.

## 1 INTRODUCTION

The issue of trust has been paid all the while by multidisciplinary such as psychology, sociology, economics and other subjects concern. Psychologists emphasize the internal nature of the trust, and they consider trust as inherent personality traits and a kind of human expectations, beliefs, confidence, varying with different individuals. Sociologists stressed the externalities generated by trust that the trust is a simplified mechanism as the product of social mechanism and cultural norms. And trust is a social phenomenon based on legal (laws and regulations) or ethical (social and cultural norms) and a kind of believe that other people can look forward to cooperative behavior. While economists argued that, trust is a result of the individual's rational choice when the benefit of trust is greater than that of no confidence. Trust was discussed by different disciplines from different perspectives, in the resulting of different understanding, thus the definition of trust has been unable to unify. Until 1995, Mayer et al (Mayer et al., 1995) advanced the notion of trust currently widely accepted based on a comprehensive understanding of various disciplines, that one side always thought that the other part will act in accordance with his manner regardless of his monitoring and control abilities, thus he is willing to put his own in the state of risk.

Along with the appearance of network transaction methods, the issues network trust have caused computer science concerns and made certain achievements, especially in the area of trust model research. Marsh (Marsh, 1994) (1994) was one of the earliest scholars who carried out trust formalistic research on the basis of sociology. He divided trust into three types: basic trust, general trust and situational trust, and proposed a calculable trust model under the distributed artificial intelligence environment. In the model, Marsh defined basic trust as an individual tendency of trust dereferencing in the interval  $[-1,1]$ , and he stressed that the basic trust varies with different individuals because of different individual tendency. Beth (Beth et al, 1994) (1994) introduced the concept of experience and used the method to express the measure of the probability of trust. Trust is defined in the interval  $[0,1]$ . The model defines two kinds of trust relations: direct trust and recommendation trust. Beth also gave the first formula of recommendation trust worthiness: namely, is the trust worthiness derived from a single path, and the comprehensive recommendation trust worthiness is simple average of these single-degree recommendation trust worthiness. Abdul-Rahman et al (Abdul-Rahman, 2000) (2000) considered no practical significance about continuous quantitative trust, they divided trust according to semantic variables as fully trust, great trust, trust, a little trust, not trust, not trust at all, and the discrete values

are 4,3,2,1,0, -1. Tang et al (Wen and Zhong, 2003) (2003) believe that trust is essentially a faith-based, with subjective and ambiguous character, he draw fuzzy set theory into trust management studies and used the grade of membership to describe the ambiguity of trust. They defined the trust vectors as measurement mechanism of trust, and adopted method of fuzzy comprehensive evaluation to measure trust. But the model denied the random of trust, and considered the ambiguity as the unique characteristics of trust. Song et al (Song and Hwang, 2005) (2005), proposed the dynamic trust model based on fuzzy logic under network environment in account with the dynamic nature of trust. In their model, they not only took into account the evidence production of dynamic trust value, but also took into account historical factors, and got the final trust value through these two weighted average. But this model did not take into account the factor of time. Wang Liang et al (Liang and Dan, 2008) (2008) introduced time attenuation function into their trust model, and pointed out that the attenuation coefficient values may be dependent on the user's specific strategy. Ma Li et al (Li and Weimin, 2009) (2009) also pointed out that the trust worthiness is relevant to time and will decay over time continuity. They defined this feature of decline property of time.

As a virtual trading method, the auguries of internet banking look gloomy. The lack of customer s' trust on internet banking is one of the most important reasons of its development restrict [9,10,11]. Therefore, the issue of customers trust on internet banking is paid more and more attention at home and abroad. At present, most scholars consider internet banking as an information system, they assumed that trust is one of the factors that affected customers' use of internet banking, and through the use of the technology acceptance model proposed by Davis (Davis, 1993), they used structural equation model and empirical methods to test assumptions reasonable. The results show that: Customers trust indeed has a positive correlation with their intention [13,14,15,16,17]. However, whether the customer choose to use internet banking, it's closely related to the trust worthiness, and only it exceeded the threshold value of the customers, will the customer use it. But at this stage it is short of research work specifically on quantitative aspects of customers trust on internet banking. Therefore, this article tries to build trust evaluation model about internet banking customer based on the above-mentioned research. Through the use of this model, the managers can detect and manage the customers' trust to develop a more reasonable measure to increase the

customers' trust, so as to promote the healthy development of internet banking.

This paper is organized as follow: section II defines the important conceptions used in setting session; Section III establishes the trust evaluation model on the stage of before the use of internet banking and the after phase when the customers have used; and finally a conclusion should be drawn.

## 2 DEFINITION

In order to research conveniently, it is needed to explain several key concepts:

### (1) Basic trust

In general, before the customers use internet banking, it has a trust value, this trust worthiness is the most primitive trust of the individual on others or things, known as basic trust.

### (2) Recommendation trust

Recommendation Trust is established according to the recommendation of other entities to a relationship of trust, but not conducted from the two entities' direct deal. And the trust worthiness between them is based on the results of the assessment from other entities.

### (3) Direct trust

Direct trust is also known as the direct experience or knowledge-based trust, it generates in the process of direct contact of a trusted party with trust party. Trust worthiness will increase along with their experience and the results would change with constantly revised.

### (4) Trust worthiness

The size of the trust can be quantified, and usually expressed by trust worthiness. Also it is known as trust level of or trust value. It can use the fuzzy variables, such as "trust", "no trust", etc. It can also use the real numbers or probability in [0,1]. In this paper it is defined in the interval of [0,1].

## 3 CUSTOMER TRUST ON INTERNET BANKING

The formation and evolution of customers trust on internet banking are dynamic process. With the increasing of the time of transaction and the level of transaction satisfaction, their mutual trust worthiness will be in progressive development of infancy to maturity (Corritore et al., 2003). This dynamic is specifically manifested in two aspects: first, the

customer trust on internet banking over changes over time. At different times, in different scenarios, customers trust on internet banking will not be on the same level. For example, the customer trust is relatively low because of his unfamiliarity with internet banking when at the first time. But as the time of transactions and their own experience increasing continuously, the trust will increase. Second, factors influencing on trust are at different stages. In the initial stage of the formation of trust relationships, customers are unable to conduct and predict a comprehensive risk assessment because of unfamiliarity. At this stage, the factors of customer trust mainly depends on the basic trust and others recommendation trust. And when the customer makes trust decisions after using internet banking, the above two factors will be gradually weakened. At this moment, the major factor comes from in the process of the direct interaction and accumulated experience and knowledge. Customers adjust their trust based on the experience each time they use internet banking. If they are able to achieve the desired effect, then the trust may increase. On the contrary, the trust will diminish, even disappear (See Figure 1).

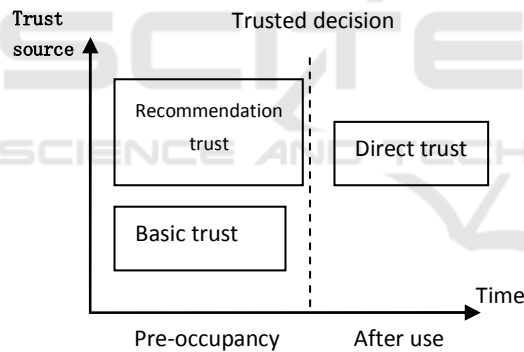


Figure 1: The Dynamic Process of Customer Trust on Internet banking.

In general, consumers are called potential customers before they really use internet banking transactions. The potential customers will become real customers once they have used internet banking transactions. Therefore, then, we establish the customer trust evaluation model divided into two kinds of cases: first, trust evaluation model of potential customers; second, evaluation model of the reality customers.

### 3.1 The Evaluation Model of Potential Customers

#### 3.1.1 Basic Trust

Before customers use the internet banking transactions, actually they have had an initial trust already, the trust called initial trust is the basic trust Marsh has explained, and the basic trust is related to the tendency of individuals. Trust tendency is considered general trust and basic position as a whole of the main body for other persons or things. In theory, such a general trust can impact on the trust judge on any specific person or thing. Because they are all different in their main growth experience and personality traits, as well as different cultural backgrounds, so trust will vary accordingly. The higher the customers trust tendency, the larger the trust worthiness he has. On the contrary, the initial trust worthiness is lower. Now, we use a mathematical model to describe the basic trust of potential customers.

Suppose that  $TP'_x$  is basic trust of customer  $x$  at the moment  $t$ , basic trust is different for different customer, therefore:

$$TP'_x = \alpha_x, \alpha_x \in [0,1] \quad (1)$$

The trust tendency of customer  $x$  is expressed by  $\alpha_x$ . Because each person's trust tendency is stable, so  $\alpha_x$  is a fixed constant. If the values of  $\alpha_x$  is closer to 0, it is indicated that the initial customer trust is low; if it's closer to 1, it is indicated that the initial customer trust is high.

In practical applications, we can use rating scales to measure customer trust tendency and determine the value of  $\alpha_x$ . Rating scale is the most commonly used psychometric instruments, and the semantic quantifier is an important part of rating scales evaluate the amount of psychological applying the level of natural language. Cicchetti (1985) studies show that: In the rating scale, the use of seven quantifiers is the most suitable (Cicchetti and Showalter, 1985), because if the semantics of quantifiers rating too few, the sensitivity of scale will be significantly reduced. On the contrary the grading will be too much to distinguish the subjects' areas so that the evaluation results would be affected. According to the thoughts of Cicchetti et al, we use seven semantic quantifier to measure the customer's trust, that is "fully believe," "trust," "a little trust," "uncertain," "somewhat do not trust," "do not trust," "do not trust at all". The quantitative approach is to

convert the semantic quantifier to equidistant values, if "fully trust" means 1, and then "do not trust at all" means 0.

### 3.1.2 Recommendation Trust

Trust has transmission characteristics. When the potential customers are short of understanding of internet banking or relevant information to judge the trust, they rely on the recommendation information of the third parties, such as customer's word of mouth and the recommendation of some trust assessment agencies. For example, customer A who has never used internet banking can consult customer B who has had such transactions, and customer B would supply some trust-related information to customer A, then Customer A will build his trust on the internet banking through customer B. See figure 2 below:

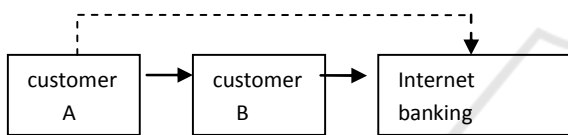


Figure 2: Trust transmission diagram.

Suppose at the moment  $t$ , the customer  $x$  has received  $n$  recommendation trust worthiness from  $n$  recommended persons (or advertising media, third-party of network trust evaluation certification agencies),  $TR_x^t$  is expressed the recommendation trust worthiness on the internet banking generated by others' recommendation. Then,

$$TR_x^t = \frac{\sum_{j=1}^n (v_x^j \cdot tr_x^j)}{\sum_{j=1}^n v_x^j} \quad (2)$$

$$tr_x^j \in [0,1] \quad v_x^j \in [0,1] \quad j = 1, 2, 3, \dots, n$$

In the formula above,  $tr_x^j$  expresses the trust worthiness that person  $j$  recommends to customer  $x$ .  $v_x^j$  represents the customers  $x$  focus of the recommended information. If the value of  $v_x^j$  is closer to 1, it is indicated that the recommendation of the information has great the impact on customer  $x$ . On the contrary,  $v_x^j$  is closer to 0, it indicates the recommendation of the information has little the impact on customer  $x$ .

When applied, customers focus can still be measured by rating scale too. Semantic quantifier can use the seven levels as "take too much count," "take much count," "take count," "generally" and

"give a little attention," "give little attention," "not give attention at all". If the value of "take too much count" means 1, "not give attention at all" means 0.

### 3.1.3 Comprehensive Evaluation of the Potential Customers Trust

As noted above, the potential customers trust depends largely on the basic trust and recommendation trust. Customers will adjust their own trust based on their basic trust on the internet banking and the recommendation trust. Suppose that the basic trust of a potential customer on internet banking is relatively high, but the recommendation trust from other people is low, so his trust worthiness on the internet banking may be reduced. On the other hand, his basic trust has just started in relatively low level, but the recommendation trust from other people get relatively high, his trust will improve. Therefore, the comprehensive assessment of the trust should make a synthesis of basic trust and recommendation trust, and thus get the overall trust on internet banking. So, how to merge two of them is the key to the establishment of the model. In order to study conveniently, we consider the potential customers as the recommending one by themselves, so that the basic trust and recommendation trust can be liable to the same treatment. Hereafter, we use weighted average method to the synthesis of the value of potential customers trust on internet banking.

Suppose that  $Trust_x^t$  represents the trust of potential customer  $x$  at the moment of  $t$ ,  $TP_x^t$  represents the basic trust of customer  $x$  at the moment of  $t$ , and  $TR_x^t$  represents the recommendation trust of customer  $x$ . Then,

$$Trust_x^t = w_1 \cdot TP_x^t + w_2 \cdot TR_x^t \quad (3)$$

In the above formula,  $w_1 + w_2 = 1$ ,

$w_1, w_2$  respectively represents the trust tendency and the share weight of recommendation trust from others in the overall trust.

## 3.2 Trust Evaluation Model of Real Customers

The real customers have already used internet banking, so their trust worthiness are associated with their actual experience. In general, if the customer has used the internet banking repeatedly, then the

customer trust is not only associated with the current transaction, but also associated with his previous evaluation. According to their actual experience, customers will continue to adjust and update their trust on the internet banking. In normal conditions, satisfaction with the results of collaboration is basis of trust relationship, and satisfaction largely determines the level of trust. So the customers trust can be measured by their satisfaction with the results of collaboration. If the customer is satisfied with the internet banking, his trust on the internet banking will increase, otherwise that will be reduced. We describe the different satisfaction by discrete scale and natural language at the same time, as shown in Table 3.

The following, we will describe direct trust of the real customers by mathematical method:

Assume that customer  $x$  has used internet banking for  $n$  times, the variable  $dt_x^i$  indicated that satisfaction of customer  $x$  at the  $i^{th}$  time transaction,  $DT_x^n$  represents the direct trust of customer  $x$  after the  $n^{th}$  transaction. Then after the customer used internet banking for  $n$  times, the calculation of his direct trust is divided into two situations:

①when  $n = 1$ ,

$$TD_x^1 = td_x^1 \tag{4}$$

When customer uses internet banking the first time, his trust is right the first time usage evaluation because of his short of accumulation about relevant experience.

②when  $n > 1$ ,

$$TD_x^n = \alpha \frac{\sum_{i=1}^{n-1} w_i td_x^i}{n-1} + (1-\alpha)td_x^n \tag{5}$$

Among them,  $\frac{\sum_{i=1}^{n-1} w_i td_x^i}{n-1}$  indicates average value of the trust of customer's history, and  $w_i$  ( $0 \leq w_i \leq 1$ ) represents the time weighting factor.  $\alpha$  and  $1-\alpha$  respectively represents the average value of customer's history and the share of current trust in the updated trust value. Generally speaking, if the history of trading is farther away from current, then the smaller  $\alpha$  will be, on the other hand, the greater  $\alpha$  will be.

The time weighting factors  $w_1, w_2, \dots, w_{n-1}$

represent the degree of customer focus at moment. Scientific determination of weight vectors is the key to get a reasonable result of evaluation. Time weight vector can be determined according to different criteria. Next, we use entropy method to determine the value of  $w_1, w_2, \dots, w_{n-1}$ . Entropy is called average amount of information in information theory, which is a measure of information. The entropy value greater, the smaller amount of information contained.

First, introduce the definition of entropy  $I$  of time weighting vector and time-degree  $\lambda$ :

$$I = -\sum_{k=1}^{n-1} w_k \ln w_k \tag{6}$$

$$\lambda = \sum_{k=1}^{n-1} \frac{n-1-k}{n-2} w_k \tag{7}$$

The entropy  $I$  of time weighting vector reflect different level of information contained included in the weights.  $\lambda$  reflects the degree of emphasis on the timing (See Table 1). When  $\lambda$  is closer to 0, it is indicated that the more attention paid to the more recent data by the customer, reflecting the idea of time decaying.

Secondly, fix  $w_k$ . In the situation of a given  $\lambda$  in advance, now we solve the following linear programming problem:

$$\begin{aligned} \max & \left| -\sum_{k=1}^{n-1} w_k \ln w_k \right| \\ \text{s.t.} & \lambda = \sum_{k=1}^{n-1} \frac{n-1-k}{n-2} w_k \\ & \sum_{k=1}^{n-1} w_k = 1, w_k \in [0,1] \\ & k = 1, 2, \dots, n-1 \end{aligned} \tag{8}$$

Table 1: The Reference Table of Time-degree Scale.

$\lambda$	Illustration
0.1	Take highly account of recent data
0.3	Take relatively account of recent data
0.5	Equally in every stage
0.7	Take more account of long-dated data
0.9	Take highly account of long-dated data
0.2、0.4、0.6、0.8	Corresponds to the middle of the above two adjacent data to determine

For example, when  $\lambda = 0.1$ ,  $n = 6$ ,  $w = (0.0029, 0.0086, 0.0255, 0.0755, 0.2238, 0.6637)$ .



## 4 CONCLUSIONS

This paper established a two-stage model of customers trust on internet banking including stage of Pre-occupancy and after usage. The model has certain maneuverability so that bank managers can use it to measure customers trust at different time, so as to support strong data for bank management decision-making.

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