Study of Continuity Trust on Adoption and Design of e-Education and Student Development

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Abstract—**Trust or trustworthiness is an important issue in e-education and development of students' capabilities. Factors to calculate trust level have been studied to provide valuable information to students to avoid invalid choices. While some education branches provider and fraudulent services online still widely exist. A typical one is to attract students with ideal price or service but fail to deliver a solid item. This behavior is often carried out by a newly registered e-education. This paper proposes a new trust evaluation model to indicate to some extent the trust level of an e-education firm or service provider at different registered time. We describe our proposed approach for continuity trust evaluation, which evaluated empirically in the paper.**

***Index Terms*—algorithm, e-Education, continuity, trust**

I. INTRODUCTION

Increasing database management capabilities enable e-education firms to focus on mass-customization rather than mass marketing and students' retention rather than recruitment [1]. Nowadays online education platform is ubiquitous and is an essential facilitator of communication in online transactions and in the daily life of e-education.

Some empirical studies have investigated the role of trust in the specific context of e-education and, focusing on different factors [2]. However, empirical research in this area is beset by conflicting conceptualizations of the trust construct, inadequate understanding of the relationships between trust, its antecedents and consequents, and the frequent use of trust scales that are neither theoretically derived nor rigorously validated [3]. Elements and factors of e-education trust are used interchangeably in many studies [4].

In this paper, we propose the notion of continuity trust and its method of evaluation. In addition, we also propose an algorithm for calculating continuity trust. The two approaches correlated to each other and lad to an iterative process for computation. In Section2, we review the trust evaluation in e- education or and some existing studies. Section 3 discusses the metrics of continuity trust computation and presents our proposed approaches. Empirical studies are presented in Section4 and Section 5 concludes our work briefly.

II. THEORETICAL BACKGROUND

Trust is important in explaining customers' economical and social behaviors, especially for the student to make purchasing decisions [8]. Its absence frustrates existing bonding and causes misunderstandings [9]. The issue of trust in markets has received considerable attention in the end of 20th century [10-12]. In their study trust is essential because it can decrease the operational costs considerably, increase the information sharing and fasten relationship [13]. Consequently, many scholars have suggested that trust is an important factor in explaining customer retention.

Moreover, according to Morgan [8], the conclusion of the compartmental component could be redundant, as a result of the cognitive component. In previous literature trust is defined as one party's confidence that the other party in the exchange relationship will not exploit its vulnerabilities in e-education service. At the same time, trust would function in situations where the "trustworthy" party in e-education service: (1) is known to reliably make good faith efforts to behave in accordance with prior commitments, (2) makes adjustments (e.g., as market conditions change with online customers) in ways perceived as "fair" by the exchange partners, and (3) does not take excessive advantage of an exchange partner even when the opportunity is available[10]. The trust referred in this study can be classified as interpersonal trust[21] which means that people more than two trust each other in a certain online platform.

Information asymmetry, a situation where two parties do not possess the same information has been recognized as one of the main reasons for trust deficiency online. Various factors should be considered to evaluate the degree of trust, including cultural diversity, interaction experiences, cooperation and communication, employee propensity to trust, employee perception of trustworthiness. It is difficult to evaluate trust with crisp values because it involves ambiguity and subjectivity and to estimate experimentally by modeling some graded phenomenon.

Fuzzy theory has been taken to evaluate online trust [6] since it is a highly intuitive approach to analysis using natural language labels that represent intervals rather than exact values. Based on Robinson and Gao's contribution, Schmidt [11] developed a new fuzzy model to compute the trustworthy of online partners to facilitate the selection of the best matched and most trustworthy online partners.

Continuity represents the duration of association among business partners. Previous literature discussed the importance of the years of association among the partners, which has great effect on modern business [4]. Our research will define continuity as the number of year/month between the education and student in e-education markets and refer to this construct as organizational level.

III. CONTINUITY TRUST EVALUATION IN E-EDUCATION

In this section, the data structure for continuity trust evaluation and trust evaluation metrics will be presented, based on which we will deliver the continuity trust evaluation method.

Continuity Data Structure of e-education In order to calculate the continuity trust, we assume the following trust data structure.

$$TR = \left\{S, C, R^{t}_{C\to S}, P, c_o, t\right\} \quad (1)$$

Where:

TR is the transaction occurred at time t between e-education or service provider S and student or service customer C;

P=pd (TR) is the product or service purchased in the transaction;

c_o=pr (TR) is the existing time of the product or service e-education registered in the platform;

$R^{(t)}_{C\to S} = rating(TR) \in [0,1]$ is the rating given by C;

$tran(R_{C\to S})$ is used to denote transaction TR.

Generally, an online product or service purchaser is concerned about whether the e-education is trustworthy. Word-of-mouth and reputation are two important factors to measure the trust level of a certain e-education. Besides which, the continuity (existing time) of the e-education is also a key reference factor. If the continuity is too short, it indicates high transaction risk level and thus low transaction trust. Actually, some malicious e-educations firms intend to cheat in transaction are new registered organizations by offering low price. The Continuity Trust *(CT)* is expected to identify this type of cases and leave risk indication to potential students.

Continuity Trust results from the comparison of the existing time of the e-education and the average existing time of all e-education firms. This continuity trust value is useful to prevent the fraudulent transaction by offering attractive exchange conditions, which are the most common fraud tricks online. The continuity trust can be computed form the distance of the e-education existing time and the average one. If the education existing time is much shorter than the average time, it indicates a low continuity trust and a relatively high transaction risk. Meanwhile, if the e-education existing time is much higher than the average one, it also indicates a high transaction risk and low continuity trust. Consequently, a trustworthy e-education should be close or above the average existing time in online markets.

Let $\delta_c = \dfrac{c_o - c_a}{c_a}$ denote the continuity distance in percentage, where c_o the e-education existing time and c_a is the market average existing time. Some principles for calculating continuity trust are discussed as follows.

Principle 1: The continuity trust value can be in the range of $[0,1]$, where 0 represents the lowest trust value and 1 represents the highest trust level.

Principle 2: If the e-education continuity c_o is in the normal range in $[c_{o-}, c_{0+}]$ $(c_{o-} < c_a < c_{0+})$, CV is considered as 1 when $c_o > c_{o+}$, here δ_c can be redefined as follows.

$$\delta_c = \begin{cases} 1 & if \quad c_o > c_{0+} \\ \dfrac{c_o - c_{o-}}{c_{o+} - c_{o-}} & if \quad c_{o-} > c_o > c_{0+} \\ 0 & if \quad c_o < c_{0-} \end{cases}$$

Principle 3: $CT \in [0,1]$ is a function of δ_c, and its value is in reverse proportion to $|\delta_c|$, if $\delta_c \neq 0$.

Principle 4: CT is a continuous or approximately continuous function of δ_c.

If there is a discontinuous point δ_0, the CT for δ_0 is much different from the one for $\delta_0 + \varepsilon$ (ε is an arbitrary small positive value in $(0,1)$). However, it is a controversy since CT has no such jump point.

Principle 5: If $|\delta_{c1}| = |\delta_{c2}|$, $\delta_{c1} < 0$ and $\delta_{c2} > 0$, CT_1 may be different from CT_2, where CT_1 and CT_2 are the corresponding CT for δ_{c1} and δ_{c2} respectively.

Principle 5.1: If both $|\delta_{c1}|$ and $|\delta_{c2}|$ are close to 1, $CT_1 \geq CT_2$

Principle 5.1 tries to clarify that e-education who just registered may not cheat in a deal, but has the least conversion cost if intend to do so. If co is less than but very close to c_{o-}, CT is close to 0.

Principle 5.2: If both $|\delta_{c1}|$ and $|\delta_{c2}|$ are close to 0, $CT_1 < CT_2$.

Principle 5.1 tries to clarify that a deal of integrity offered by a truthful e-education. For example, normally it is common for a education with great reputation to abide by the rule of business with a long continuity in an online platform than a new registered one.

We will construct the evaluation models for Continuity Trust in this section.

Let $T_{S(c_o)}$ denote the continuity trust of e-education S with continuity c_o. According to Principle 1 and 2, given c_{0-}, c_{o+} and $c_o \in [c_{0+}, +\infty]$, $T_{S(c_o)}$ =1, and $c_o \in [0, c_{o-}]$, $T_{S(c_o)}$ =0.

Let's take the case $\delta_c = \dfrac{c_o - c_{o-}}{c_{o+} - c_{0-}} < 0$, where $c_o < c_{o-}$. According to Principle 3, a larger $|\delta_c|$ results in a smaller CT, which approaches 0. To simulate this property, Hyperbolic Tangent function is adopted and transformed into the following formula. If $\delta_c \in [-1,0)$, we have:

$$T_{S(c_o)} = \frac{e^{\lambda\eta} - e^{-\lambda\eta}}{2\left(e^{\lambda\eta} + e^{-\lambda\eta}\right)} + 0.5 \tag{3}$$

Where $\eta = 2\delta_c + 1$, and $\lambda \geq 1$ is the argument for controlling the function curve. As the Hyperbolic Tangent function $f(x) = \frac{e^x - e^{-x}}{e^x + e^{-x}}$ is in the range of $[0,1)$, we can conclude that $T_{S(c_o)} \in (0,1)$.

For the case of $\delta_c > 0$, it is a little different for the case of $\delta_c < 0$. Firstly, in the case of $\delta_c < 0$, δ_c is in the range of $[-1,0)$. But if $\delta_c > 0$, it is quite possible that $\delta > 1$. Secondly, the change tendency of CT is different from the case of $\delta_c < 0$. In formula (3), when $c_o < c_{o-}$ but c_o is close to c_{o-}, CT is close to 0 but with a small possibility of trustworthiness. When c_o is far away from c_{o-} by a certain distance, CT will be 0 without a small possibility of trustworthiness. In addition, as it is possible for δ_c decreases to 0, CT approaches to 0 more slowly than that in the case of $\delta_c < 0$. Namely, according to Principle 5.2, if $|\delta_{c1}| = |\delta_{c2}|$, and $\delta_{c1} < 0$ and $\delta_{c2} > 0$, we can assume that δ_{c1} and δ_{c2} are not close to 1, $CT_1 < CT_2$. We have the formula of the evaluation of CT by taking the transformation of the Hyperbolic Secant function. If $\delta_c \geq 0$, we have:

$$T_{S(c_o)} = \frac{2}{e^{\delta_c\gamma} + e^{-\delta_c\gamma}} \tag{4}$$

where $\gamma \geq 1$ is the argument for controlling the function's curve.

Definition 1: Let c_o and c_a denote the existing time of the e-education S and the average existing time of all e-education firms of a certain product or service, we have

$$\delta_c = \begin{cases} \dfrac{c_o - c_a}{c_{o+} - c_{o-}} & if \quad c_o > c_a > c_{o+} \\ \dfrac{c_o - c_{o-}}{c_{o+} - c_{o-}} & if \quad c_{o+} > c_o > c_{0-} \\ \dfrac{c_o - c_{o-}}{c_{o+} - c_o} & if \quad c_o < c_{o-} < c_a \end{cases} \tag{5}$$

The continuity trust CT can be evaluated as

$$T_{S(c_o)} = \begin{cases} 1 & if \quad c_o > c_a > c_{o+} \\ \dfrac{2}{e^{\delta_c\gamma} + e^{-\delta_c\gamma}} & if \quad c_{o+} > c_o > c_{0-} \\ \dfrac{e^{\lambda\eta} - e^{-\lambda\eta}}{2\left(e^{\lambda\eta} + e^{-\lambda\eta}\right)} + 0.5 & if \quad c_o < c_{o-} < c_a \end{cases}$$

(6)

In (6), $\eta = 2\delta_c + 1$, $\gamma \geq 1$ are arguments for controlling the function curve. The CT function is transformed from the Hyperbolic Secant function which between $[0,1)$ and Hyperbolic Tangent function which between $(-1,1)$. Therefore the CT function is in the range of $(0,1]$. The setting of γ and λ in the function will be discussed in next section.

Within a highly centralized online platform, as all e-education firms and service providers are operating in one platform. Consequently, it is convenient to calculate the continuity or existing time of all e-education firms of a certain product or service. We assume the average continuity of a certain product or service PS could be measured as the mean of the continuity of all e-education firms. Namely,

Definition 2: Let c_{oi} denote the continuity of e-education of product or service PS, the average continuity of all PS e-education firms in a naïve strategy can be calculated as follows:

$$c_{oPS} = \frac{1}{n}\sum_{PS_i} c_{oi} \tag{7}$$

Where h is the number of e-education firms who selling PS.

It is assumed that all e-education firms have the trustworthiness of their won. With c_{oPS}, the CT values can be measured for each e-education's continuity. The new continuity trust can be calculated after filtering out some trustworthiness noise.

Definition 3: Let c_{oi} denote the continuity of a PS e-education, the trustworthiness of PS c_o can be computed as follows:

$$c'_{oPS} = \frac{1}{n'}\sum_{CT(c_{oi})} c_{oi} \tag{8}$$

Where n' is the number of e-education firms whose CT is larger than a threshold ρ, i.e. $CT(c_{oi}) \geq \rho$.

Moreover, the above calculation does not take all CT into account when computing the average continuity of PS. On the contrary, the CT is taken to filer out low trust continuity. Consequently, the CT of each trustworthiness continuity can be taken as a weight when calculating the average continuity. Therefore, we propose a new average continuity evaluation method as follows.

With equation 8, we can conclude that the evaluation of CT is an iterative process as with the new selling join the market, the CT values may filter out some low trustworthy e-education firms of PS. This iterative process can be repeated until each value becomes stable. The iterative algorithm is described as algorithm1 Compute average continuity of PS e-education firms c_a.

IV. CONCLUSIONS

With deductive research, the paper discussed the continuity of trust online, set up a theoretical model about the trustworthiness of organizations and testified the model based on empirical data. A new trust evaluation model is presented to indicate that to some extent the trust level of an e-education or service provider at different registered time differs significantly. In addition, an iterative algorithm to duration cost is offered, which can contribute to the calculation of the CT. The computed CT and duration cost are essential and valuable to online students or e-education to make reasonable decision.

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