Assessing and Assuring Trust in E-Commerce Systems

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Abstract

On-line trading or Internet Commerce restoring to E-Commerce systems are gradually replacing the traditional commerce activities. Internet users must have reasonable faith on the underlying systems before comfortably using it, To convince users to confidently enjoy the benefits that Internet and E-commerce systems can bring, an E-commerce system needs to be trustful and convincing to the users.

In the paper, we proposed a computational model on which the E-commerce system can be developed, and the trust level will be introduced and assessed based on users attitudes, opinions and motivations, and provide some insight for the customers of Internet commerce. The model has two features: to assess the trust level of existing E-commerce systems, and to recommend the E-Retailers how to improve the trust level.

Based on the model, a prototype system of assessing trust level of E-commerce system has been designed. On-line based e-EI system has demonstrated the computational model is feasible and the implemented system is efficient and reliable. It is of significance in recommending the E-retailers to improve the trust level of their E-commerce systems.

Keywords: Trust, E-Commerce, Computational Model, Assurance.

1 Introduction

Internet commerce and on-line business have dramatically changed the traditional way of doing business for many years. With the technology of networking and credit system, doing business through using E-Commerce system is more efficient and reliable. Majority of developed countries in the world have been using E-commerce and enjoying the facilitation for many years, which has brought enormous benefit for their economy [1].

Technically, it is not a problem for retailer to develop a E-commerce system to do whatever a traditional commerce needs to do. The online trading, which merely replace the traditional commerce activities have achieved sufficient recognition in past years. It has been reported in [6] that total E-Commerce sales grew from 100 billions in 2002 to more than 1000 billions in 2004. Nevertheless, people still have some concerns while using the online trading systems according to surveys [5] and previous studies. Most of E-commerce users are cautiously using E-Commerce system with some uncertainties, which can be seen from buyer does not want to send money before seeing the goods, and seller does not want to ship the goods before receiving money; while they all worry about the confidentiality of private data conveying in transaction. Thus, if sufficient evidences of proving the online trading reliable and creditable can be collected and presented to potential users, E-commerce users or customers would happily accept to use and willingly pass the words to their friends. Through researching on previous work, we found that it is possible to use a mathematical model to assess an E-Commerce system by integrating all of these evidences, and other favorable commercial advertisements.

In this paper, we proposed a new trust building model and an E-commerce system which is based on the model. The rest of the paper is organized into 5 sections. In Section 2, some relevant works on the development of E-commerce systems and the research on the trust issue of the E-commerce systems are presented. The computational model which derived from the RPG (Role Play Game) model is given in Section 3.Section 4 specifically discusses how to implement the trust model into a functional E-Commerce system, and develops sustainable algorithms in this section as well. In Section 5, we described the experiments and result analysis that demonstrated the feasibility of the implementation, and Section 6 concluded the paper.

2 Related works

There are enormous E-Commerce systems currently being used on E-Business. Their impact is beginning to be felt not only in commercial sectors but also the non-commercial sectors.However, a limited number of systems which have considered the trust issues in the E-Commerce systems. From the available online systems such as Mathematical trust model and Reputation System, Patton *et al* in [4] gave a detailed overview on the methods for assessing, communicating and establishing trust in online E-commerce systems. They presented many examples fostering the consumer trust and confidence in E-commerce in a wide range of disciplines including human-interaction, usability, marketing, information technology, mathematics, linguistics and law. Yang et al have noticed the same problem as we have that the growth of E-Commerce is being severely hampered by a lack of trust between the users of E-Commerce. They developed W3FT to assess trust and transitivity of trust on web-based services in a heterogeneous Web environment. The W3FT focus on the soundness of the technology used to build up the web-based E-commerce systems [7]. A recent research work which addressed the trust issue to Chinese E-commerce system has been reported in [8]. The model is considered mainly for the E-commerce development and deployment within Chinese context.

3 ERC^2G Trust Model

In this section, we propose a computational model. The ERC^2G trust model is a trust measurement model, which is based on the idea of reputation accumulation in Role Play Game (RPG). ERC^2G combines the concept of Reputation System and Mathematical trust model, and represents 5 major information sources: direct E(xperiences), customer evaluations and R(ecommendations), digital C(redentials), C(ertificates) and system G(uarantees) to measure the trust level of an E-Retailer.

Establishing trust in E-Commerce regarded as a long term process of building good reputation and loyal trustworthiness with both customers and business partners, in which positive activities will increase the trust level, otherwise destroy reputation immediately. The ERC^2G trust model strive to gather various information from E-Retailer's activities, which might be used as criteria of trust level measurement.

As a part of base of ERC^2G model, Reputation System [2] suggests that customer feedback about E-Retailer's behaviors is another important and convincing information source to help consumer to build confidence in E-Retailer. Since on-line customer evaluation is relatively easier than it is in physical world, to avoid fraud, we will use some methods to inspect the quality, quantity and frequency of customer evaluations, and change the effect to the trust level consequently.

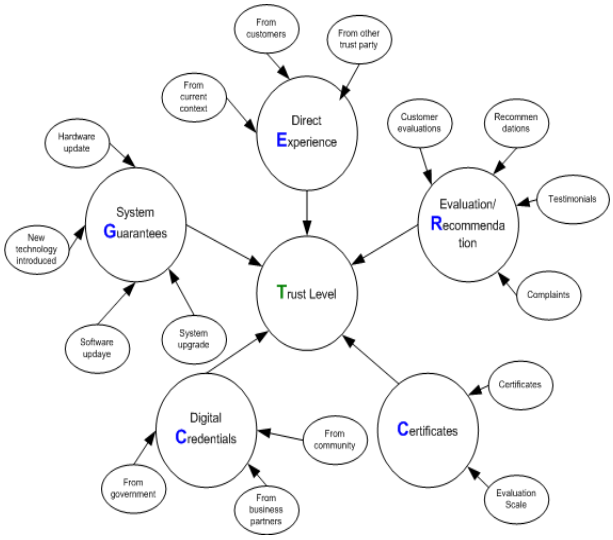

Figure 1. ERC^2G **model**

Another part of ERC^2G model is Mathematical trust model that assign different weights to each of the information sources according to their trustworthiness effect. The collected information, records, and specifications will translated into numerical values with different weight based on predefined algorithms, and let the ERC^2G model to manipulate with the numerical trust values directly.

As an integration of these two models, ERC^2G utilizes multiple information sources and assigns different weights to different information sources. The structure of the ERC^2G trust model is showing in Figure 1.

3.1 Trust Modelling

The trust level of an E-Commerce system is the summary of the contribution made by five events. These events include the communication technology advances, social and commercial value awareness, cultural background and economical changes.

With the ERC^2G Trust Model, we know that the trust level is dynamically measured. In E-Commerce, the growth of an E-Retailer's reputation is not a linear incremental relation with the time passed. At the beginning, an initial trust level is generated by the model based on E-Retailer's offline reputations, prior certificates, credentials and system guarantees. The formula of initial trust is defined as:

$$InitialTrust = T_{default} + T_{system} + T_{credential} + R_{offline}$$

Based on the initial trust level, any positive support of the 5 major trust information sources will make the current trust

level growth; or drop by contraries. To maintain the trust level in a percentage, ERC^2G trust model calculate and interpret the trust level as a percentage of current trust value and full trust with trust growth. The trust level is defined as:

$$trustGrowth = \sum T_{trading} + \sum T_{customer} + \sum T_{certificate} + \sum T_{credential} + \sum T_{system}$$

The current trust level of an E-Commerce system is updated after any kinds of events took place.

$$TrustLevel = \frac{T_{current} + trustGrowth}{100 + trustGrowth}$$

For instance, an E-retailer has recently successfully done a big business, then the $T_{trading}$ will be changed, how much change occurred is calculated using Algorithm 1. One other hand, if a retailer has recently received an award from the government, which praise its good service, then $T_{certificate}$ will be increased. Other events can be a retailer joins a professional body, or its E-commerce system has been upgraded with security patch, etc.

3.2 Overall Trust Level

The overall trust level of E-Commerce account on the trading trust and customer trust, and the social reputation and technical soundness.

Each of these contributing factors will take different weights when determining the overall trust level of the system. These weights are given in Table 1.

Evidence Type	Trust weight
Trading History	$w_1 : 1.5$
Customer Evaluation	$w_2 : 0.1$
Certificate	$w_3 : 3$
System Guarantee	$w_4 : 2$
Digital Credentials	$w_5 : 3$

Table 1. table:overalltrust

In this definition, we can realize that with the growth of trust level, the growth rate of that level get smaller and smaller, and approach to 0 when the trust level close to 100%, which is the perfect trust level. However, the perfect trust level is only an extreme, which can not be reached in reality. Consequently , the perfect trust curve will look like a half-parabola, which tends to a straight line in extreme (See Figure 2).

In reality, the movement of an E-Retailer's reputation appears as a convulsionary curve, which has both increase and decrease in its life cycle like shown in Figure 2. Note

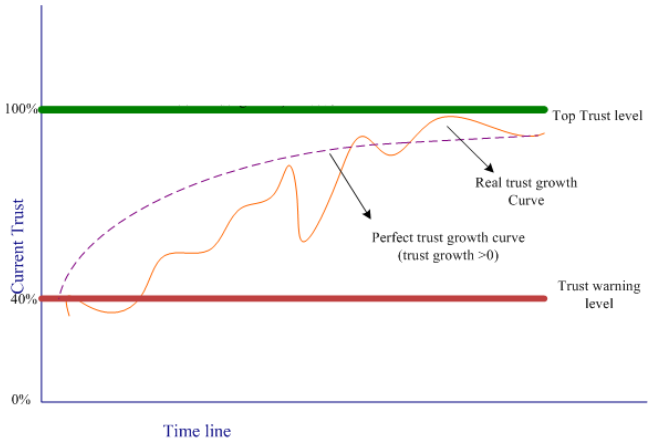

Figure 2. Curves of trust level computed by ERC^2G Trust Model

that 40% is considered as a "trust warning level" that remind both consumers and E-Retailer that the trust of that E-Retailer is concerned.

Based on the assigned weights, the main algorithm of trust level can be developed as: Algorithm 1.

Algorithm 1 Algorithm of computing Trust Level

if Information Source IS Trading Transaction **then**
  $trustGrowth = \sum tradingTrust \times w1$ {This is the process to calculate trust value of trading transaction}
else if Information Source IS Customer Evaluation **then**
  $trustGrowth = \sum customerTrust \times w2$
else if Information Source IS Certification **then**
  $trustGrowth = \sum certificateTrust \times w3$
else if Information Source IS System Guarantee **then**
  $trustGrowth = \sum systemTrust \times w4$
else if Information Source IS Digital Credentials **then**
  $trustGrowth = \sum credentialTrust \times w5$
else
  Report Error
end if
$TrustLevel = \frac{currentT + trustGrowth}{100 + trustGrowth} \times 100\%$

3.3 Trading Trust

Trading trust is about how much a trade or transaction can contribute to the trust establishment between the users and the systems. It mainly reflects how successful a trade was and how secure the whole deal process is.

The measurement of trading trust is a bit complex, since many factors may affect the trust growth, such as quantity and amount of the order, and status of the transaction. The assignments of trust weights are listed in Figure 3.

Quantity	TrustWeight
1- 5	.2
6 - 20	.4
21 - 50	.6
51 -100	.8
>100	1

Amount	TrustWeight
<500	.2
500 - 1000	.4
1000 - 5000	.6
5000 - 10000	.8
>10000	1

Status	TrustWeight
Succeed	1
Fail	-2

Figure 3. Trust weights of trading transaction

Based on the assigned trust weights, the algorithm of trading trust can be developed as: Algorithm 3.

3.4 Customer Trust

As a major part of trust level, the customer trust is how much the customer trust the system. The customer trust usually is influenced by the amount of experience users has and the degree of satisfaction.

To measure the trust effect of other trust sources like certificate trust, system trust and credential trust, E-Retailer needs to provide physical documents to as evidences. The trust value will be only increased with successful assessment.

4 Applying ERC^2G Model in E-Commerce Scenario

An online system called e-EI system, which consists of an E-commerce system and an assurance system, is developed in this section. The assurance system is developed based on the ERC^2G model.

The structure of the e-EI system is illustrated in Figure 4. It has been by integrating two subsystems: EIComputer and eTrust. Both EIComputer and eTrust are multi-tier web applications. The eTrust is responsible for monitoring EIComputer's activities, collecting customer's opinions. EIComputer and eTrust are interconnected in the structure and complementary in the functions. The user on the EIComputer can view its current trust level from eTrust; while eTrust can measure the trust level based on the information input including from the EIComputer such as the transac-

Algorithm 2 Algorithm of computing trading trust

if orderQuantity <= 5 AND orderQuantity>=0 **then**
  quantityTrustWeight=0.2 {Assign quantity Trust Weight. The more the order, the higher the perceived risk.}
else if orderQuantity > 5 AND orderQuantity < 20 **then**
  quantityTrustWeight=0.4
else if orderQuantity > 20 AND orderQuantity <=50 **then**
  quantityTrustWeight=0.6
else if orderQuantity >50 AND orderQuantity <=100 **then**
  quantityTrustWeight=0.8
else if orderQuantity >100 **then**
  quantityTrustWeight=1
else
  quantityTrustWeight=0
end if
if totalCost<=500 AND totalCost>0 **then**
  amountWeight=0.2;
else if totalCost>500 AND totalCost<=1000 **then**
  amountWeight=0.4;
else if totalCost>1000 AND totalCost<=5000 **then**
  amountWeight=0.6;
else if totalCost>5000 AND totalCost<=10000 **then**
  amountWeight=0.8;
else if totalCost>10000 **then**
  amountWeight=1;
else
  amountWeight=0;
end if
if Transaction IS successful **then**
  tradingTrust=1×(amountWeight+quantityWwight)×1.5;
  {Successful transaction make trust level increase.}
else
  tradingTrust=-2×(amountWeight+quantityWeight)×1.5;
  {Unsuccessful transaction doubling the decrease of trust level}
end if

Algorithm 3 Algorithm of computing customer trust

if evaluation IS "very poor" **then**
  trustWeight = -1;
else if evaluation IS "Not Good" **then**
  trustWeight = -0.5;
else if evaluation IS "Average" **then**
  trustWeight = 0;
else if evaluation IS "Good" **then**
  trustWeight = 0.5;
else if evaluation IS "Excellent" **then**
  trustWeight = 1;
else
  Error Message;
end if
if numOfEvaluation>0 **then**
  $trustGrowth = \sum numOfEvaluation \times 0.5 \times trustWeigh \wedge 0.1$
  numOfEvaluation= numOfEvaluation-1
else
  Out of evaluation quotas{The trust effect decreases as the number of evaluations increases}
end if

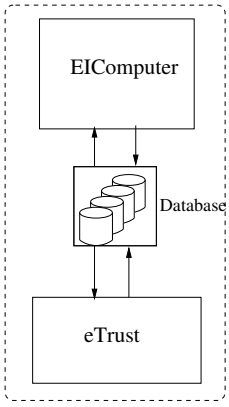

Figure 4. Structure of e-EI system

tion and from the users such as the certificates and recommendations from the government bodies.

5 Implementation of the e-EI System

Java technology has been adopted to implement the proposed system. With the rich library functions of Java programming language and the database technology, the whole implementation is mainly an integration of the XML, JDBC, servlets and JSP.

5.1 EIComputer

Within the EIComputer, an electronic storefront, the client tier is represented by user's web browser, which display static XHTML documents and dynamically created XHTML that allows the user to interact with the server tier. The possible structure of EIComputer could be like showing in Figure 5.

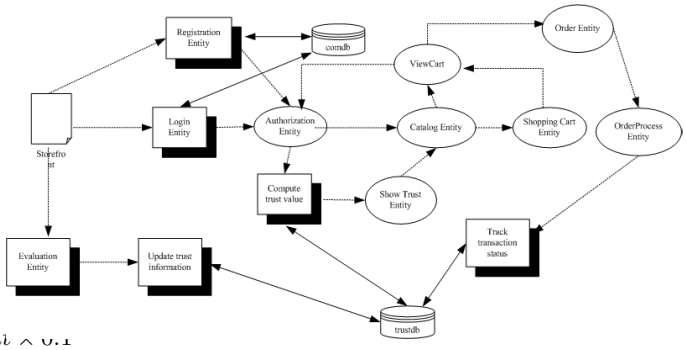

Figure 5. Structure of EIComputer

Figure 6 represents some of the user interfaces of EIComputer storefront (home page of EIComputer, product list, and customer evaluation page)that enables customers to interact with.

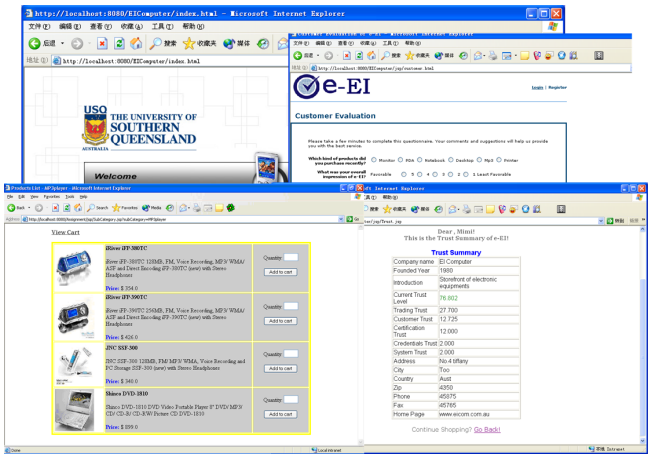

Figure 6. e-EI: Electronic storefront of EIComputer

5.2 eTrust

eTrust is actually an web application for assurance. It has been implemented as a multi-tier, client-server web based application, which could has the structure like showing in Figure 7.

eTrust always collects the information from the E-Retailer's system, and will periodically update the trust level of an E-Retailer's by the use of Algorithm 1, and 2, and 3.

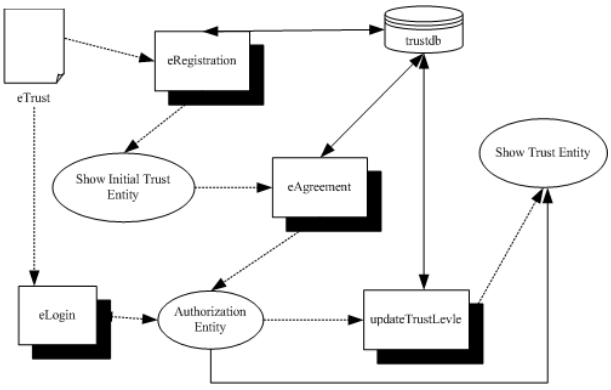

Figure 7. Structure of eTrust

Figure 8 represents the interfaces of e-Trust, which enables retailer to view and maintain their trust levels.

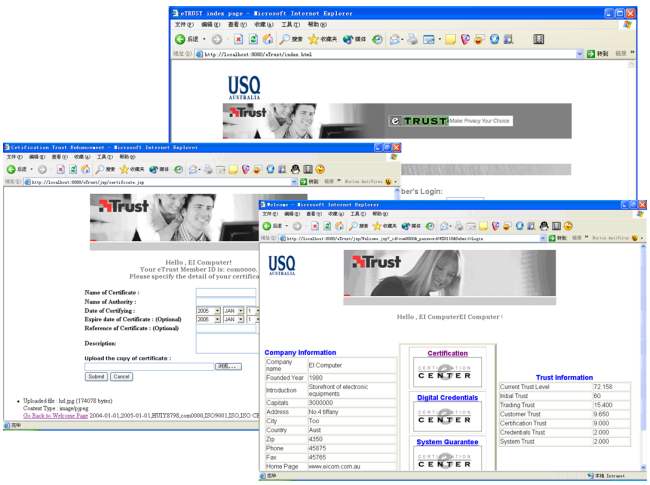

Figure 8. e-EI: Electronic storefront of EIComputer

5.3 Database

A relational database could be developed to collect the information from the E-Retailer's system, the database will periodically update its contents including the trust level. Any user can browse any E-retailers trust level from the Internet. The update on some information will be done by the administrator of the eTrust.

6 Conclusion

In this paper, a computational model of assessing the trust level of E-commerce systems has been discussed. This model has two features: assess the trust level of existing E-commerce systems and provide the developer with some suggestions or recommendations when they develop an Internet E-commerce system in the future. Establishing trust must be a complex process that needs to involve more information sources to maintain trust level, so continuous improving and enhancing the trustworthiness will be the main objective we need to achieve in future work.

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