Offering a Model of Evaluation of Trust Suggesting Between Customers and E-Stores (B2C) Based on Approaches of Fuzzy Logic

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Abstract

To succeed in the e-commerce depends on lots of factors; one of the important and vital ones is trust. In this Paper, we will suggest a model of Fuzzy Logical System which depicts some of the hidden relationships between the critical factors such as security, familiarity, and designing in a B2C commercial website on the one hand, and the competitive factor to other competitors on the other hand. We are going to find the impact of these factors on the decision-making process of people to buy through the B2C commercial websites, and we also will analyze how these factors influence the results of the B2C trading. The study also provides a device to sellers in order to improve their commercial websites; in addition, it provides on-line customers a helping device to buy through the commercial websites. In the study, the sample in the first questionnaire was the investigation of experts of e-commerce, and in the second one was the customers of commercial websites. Also, we have used the Expert Choice software to determine the priority of factors in the first questionnaire, and the SPSS and Excel software for sampling and analysis procedures to find the Fuzzy rules. Finally, we used the Fuzzy logical kit in the MATLAB software to analyze the factors which generate the model.

Keywords: Fuzzy Logic, Trust, Clustering, Rules, E-commerce.

1. INTRODUCTION

The lack of trust in different components of the most e-commerce applications is known as one of the main reasons which may lead to some e-commerce companies to fail [3],[4].

Website designers must consider factors, in mind, in a website allowing the emergence of confidence between an online seller and a customer. A website retailer is the first factor that influences on the reliability of the seller toward the mind of customer, and this effect strongly can operate on the initial trust of customers [5],[7].

Marsh and Mitch in their plan, entitled as the Call to arms, have challenged the website designers and asked them to think of this point that how they can easily make the trust possible between an online website and its customers in the early stages of their partnership. They claim that websites can be designed in a special fashion so that the trust not only becomes the indivisible part of the plan, but also it can be considered as a further thought.

Furthermore, the decision about online purchase must be available based on the accurate and correct information rather than focusing on the partial insight, general concepts and individual experiences [1], [2].

The findings are mainly on the dissatisfaction of customers on the unstable E-commerce systems, a low level of personal data security, inconvenience systems, disappointing purchases, unwillingness to provide personal details and mistrust of the technology [9],[10],[11],[12],[13]. Indeed, customers may doubt the quality of the goods as they may find it difficult to engage in a transaction without proper testing, seeing and touching the products.

Moreover, a lot of trust models have been presented. Most of them are mentally active, effect as unclear and ambiguous confidence in e-commerce websites, and don't involve the experience and understanding of customers during performing online transactions [6] , [8].

Therefore, in summary, the following objectives are achievable:
•To identify trust factors between the customer and sale agents.
•To measure the effect of a factor on confidence in contrast to other factors by fuzzy logic.
•To identify factors or security components that considerably affects the customer confidentiality upon the online purchase.
•To help customers when shopping online.
•To help designers of e-commerce website to use important factors in designing commercial websites.
•To help online enterprises for finding the customer needs.
•To detect the level of transaction on a commercial website by the sale agency.

2. LITERATURE REVIEW

Trust is one of the important factors in social interactions and most dominant factors for the success of e commerce. Since e-commerce operates in a more complex environment than traditional business, a higher degree of trust is required between different stakeholders. In e-commerce, a trading party becomes vulnerable to the other party's behavior. In other words, both vendors and consumers assume risks in a transaction, although they do not meet face-to-face. A consumer can see a picture of the product but not the product itself. Vendors can make promise of quality and delivery easily, but consumers do not know if these promises will be kept. To deal with these issues, consumers and vendors must expose a high degree of online trust. Consumers' lack of trust has often been cited as a major obstacle to the adoption and widespread use of e-commerce.

The stability of a business depends on the right balance of trust and distrust. Furthermore, people face information overload, increased uncertainty, and risk when they are engaged in e-commerce. As members of an ecommerce community, people cope with these obstacles and risk

by relying on trust. The rationale of choosing the fuzzy logic approach is based on the underlying reasoning process behind online transactions, which is based on human decision-making. Though many factors influence the decision process of online transactions such as security and familiarity, the perception of an influencing feature is more important than the actual level of the feature itself. For example, if the perceived security level is higher than its actual implementation, then it will contribute positively by the users.

The Trust model presented in this study has various aspects of consumer trust, online Environment, website designs, security and familiarity of websites. We have also addressed the importance of online customer service and its impact on consumer trust. The trust model highlights the importance of building trust in the online environment with the process of customer service. The contribution to theory of this paper is based on empirical data and information from three websites regarding our research questions. Three case studies have given us intensive understanding on the area of our research.

A more comprehensive study could be conducted further considering the following points:

- Further study could be conducted on the online environment factors because websites act as the primary contact with the customers.
- It would further be interesting to conduct research on online customer service.

Too Many companies investigate lots of money on their commercial websites. It is essential for companies to know more about their websites for example how many visitors they have or how often do they buy and etc. Lots of companies lose great deal of budget just because they don't know how their website should be qualified. Today with this huge amount of competitors, all companies should have qualified websites because it is somehow essential to know that companies who use their websites for transaction, website quality may have a major impact on number of visitors. Therefore, it is obviously important to find out the dimensions of website quality and major factors which influence it, just to reserve a higher position for yourself in e-commerce.

3. PROBLEM DISCUSSION

Internet has changed every thing in our world, but there are some techniques and ways to do previous actions in virtual world (electronic world) and actually every body is looking for the Ways of promoting and being better than before.

Many times, even you experience that some websites ask you extra ordinary information than usual and you do not feel safe and forget them, never try to buy something online or do an electronic transaction.

At the same time you may quit your previous customers by unsatisfied or wrong services. So definitely you need a way to avoid loosing your customers and also change him/her to a loyal one, besides your needs to find a new customer, your target could be your costumer's trustworthiness.

It is clear that trust plays an important role on e.transactions and as an important factor, suppliers/sellers/manufacturers should focus on ways of developing/improving trust of their customers and this will be possible by understanding effective factors on trust, which by assessing them finally it could be possible to increase trust of the consumers.As an option to approach this, design of web site and improving basic infrastructures could be considered.

Actually if you have a unique vision for all your customers, certainly you can not keep all of them and make them content and loyal, so by categorizing them and finding their most important needs, you can have more customers and at the same time you can find probable future needs of other categories/customers and also it will be possible to get ready for their new demands.

From above discussion, the research problem for this study could be formulated as: To recognize and assess factors that have affects on increasing trust and depicts some of the hidden relationships between the critical factors such as security, familiarity, and designing in a B2C commercial website on the one hand, and the competitive factor to other competitors on the other hand.

4. THE STEPS OF RESEARCH

- Review on resources related to e-commerce, websites with type of b2c, and the importance of trust factor in them, and gathering information and existing models regard to confidence.
- Poll from experts about the most important criteria in the factors affecting on trust in e-commerce websites with the type of b2c, grouping factors in four major subgroups, and determining a model of trust.
- Poll from experts through questionnaires of AHP comparisons to determine the priority of each group and collect them.
- Prioritizing the viewpoints of executives and experts in the field of trust in e-commerce and b2c websites, using given scores and using analysis hierarchy process (AHP) to select the best factors of each group relied upon the priority objectives by the software Expert Choice.
- Creating a second questionnaire based on factors derived from previous stage and to poll of 150 online users in review from 3 suggested websites for discovering fuzzy rules.
- Collecting data from the second questionnaire and required computations by the Excel software and clustering data collected by the SPSS software.
- Extracting fuzzy rules from clustered data set from the former stage.
- Creating input and output memberships functions and investigates the impact of fuzzy rules on them in available fuzzy toolbox in the MATLAB software.
- Evaluating and testing the final model.

5. RESEARCH METHODOLOGY

The proposed model has been established based on this principle that each real level of transactions in B2C websites includes two factors as follows:
1-Trust (T) level in B2C web site.
2-Competitive (C) in b2c web site for purchasing purposes.
Therefore, we propose to investigate into the truthfulness of the equations 1:

$$\begin{aligned} T &= H(S, F, D) \\ L_{B2C} &= G(T, C) \end{aligned} \qquad (1)$$

The first part of equation 1 ($T = H(S, F, D)$) that has three inputs, S is as the level of security, F is as the level of familiarity and D is as the level of design and Level of trust obtains of these three parameters performance.

The second part of equation 1 ($L_{B2C} = G(T, C)$) that has two inputs, T is as the level of trust, and D is as the level of design and Level of B2C obtains of these two parameters performance. Figure 2 shows the structure of trust model.

6. FUZZY EXPERT SYSTEM COMPLETE MODEL

In order to get a complete picture of the fuzzy expert system, an inference diagram can give a detailed explanation of the processes involved. Figure 1 illustrates the steps and processes involved. The process with the crisp inputs to the fuzzy expert system; for example, this might be the crisp input for security, and familiarity to get a value for the trust level.

As can be seen, the process with the crisp inputs to the fuzzy expert system; for example, this might be the crisp input for security, and familiarity or design to get a value for the trust level.

Similarly a crisp level of Trust and Competitiveness will be required as inputs to the second level inference as given in Esq. (1). It should be noted that the initial input(s) are a crisp set of Numbers. These values are converted from a numerical level to a linguistic level. Following that the fuzzy rules are applied and fuzzy inference engine is executed. This will result in a given B2C level as varying degree of membership of fuzzy subsets of the B2C superset. The last step that is the defuzzification process, at which time we extract a numeric value for likelihood of the B2C transaction.

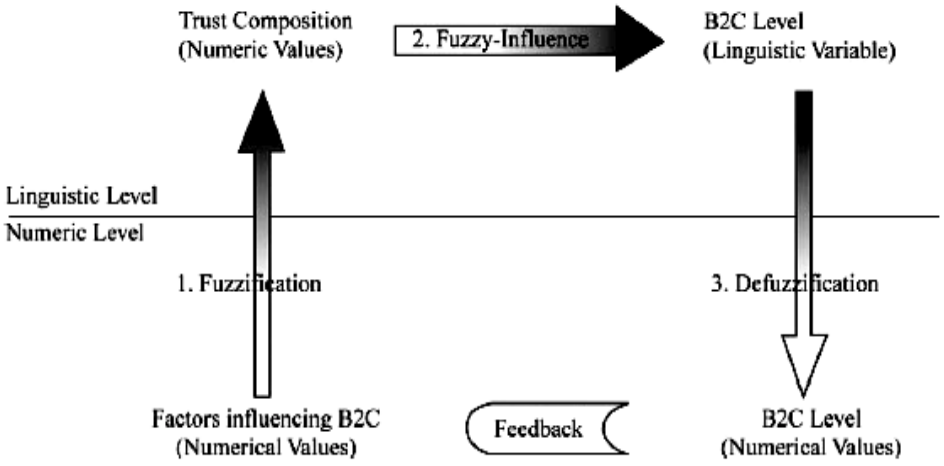

FIGURE 1: Complete Fuzzy Expert System

7. DATA COLLECTION AND ANALYSIS

This study used a web-based survey because of its advantages such as convenience; viable, effective way to access difficult-to-reach respondents.

The selected population in this study was included in two groups. The first group was included ten experts in the field of e-commerce and the Second group was included 150 numbers of E-Commerce and IT students.

The first group completed the first questionnaire and after obtaining results from the first questionnaire and the second group completed the second.

After collecting answer of first questionnaire and finding factors with higher priority, the second questionnaire was designed .it involves 4 major groups, too the method of scoring was chosen based on the likert scale of 5 degrees and 18 given questions in questionnaire were scored like 5 selections and in order of intensity of factor in each group from 0 to 4, like (0) very low (1) low (2) moderate (3) high (4) very high. In this questionnaire 16 questions are relative to 4 major groups, and 2 questions have been observed relative to the trust level and b2c level of website.

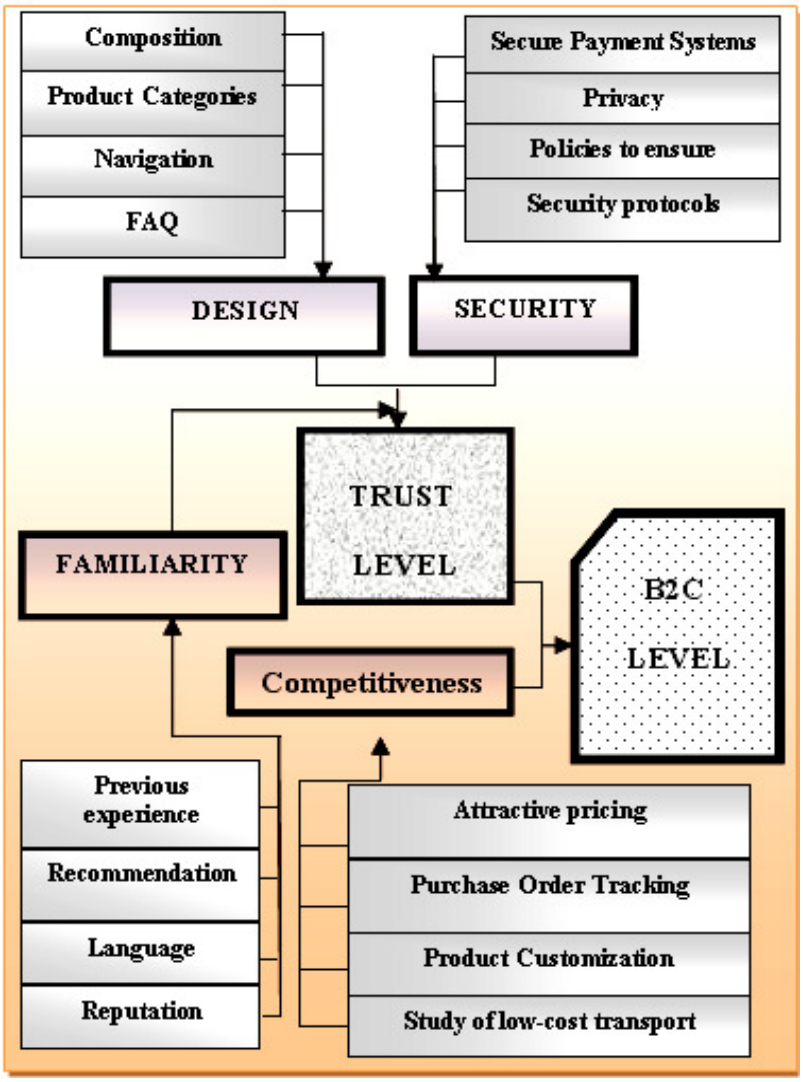

FIGURE 2: The Structure of Trust Model.

Determining the credit of questionnaire has been done by counting Cronbach's Alpha which has credit coefficient in accordance with table 1.

Cronbach's Alpha coefficient for each website		
Irshop.ir	Tobuy.ir	Parsim.com
0.85	0.83	0.83

TABLE 1: the counted credit coefficient of second questionnaire

The inserted credit coefficient in table 1 shows the acceptance of second questionnaire credit. After that customers referred to special website for experimental buying, it was asked the respondents to analyze 3 websites as parsim.com, tobuy.ir, irshop.ir.

During this process, they should answer some questions in security groups, familiarity groups, design groups, competitiveness groups, and trust and b2c level.

Finally respondents should determine the trust level competitiveness and b2c level of website after analyzing website and answering the questions.

The order of answering the questions is that first of all the respondents should analyze the website and answer the questions in security groups, familiarity, design and then they were asked to count the trust level and after that the it was weighted respondents were asked to evaluate the selective website for b2c dealings based on their expectation level of trust and competitiveness.

7.1 Calculating of security level

To count the level of security one sheet was created in EXCEL (security sheet) and linguistic values questionnaire were changed to numerical values. Actually it was related numerical value to each linguistic value (0, 1, 2, 3 and 4) in order to count the level of security the counted level of security is made by adding these values for each factor whose maximum for four factors is number 16.Also, its percent for level of security was counted that has been in table 2, and in general second equation has been used for level of security .the decided levels of design factor and familiarity are like table 2 too.

$$AccumulatedSecurityLevel = \sum_{i=1}^{4} x_i$$

$$PercentageOfMaximum = (AccumulatedSecurityLevel)/16) * 100$$

domain of values percent	Linguistic value
0-33	low
34-66	moderate
66-100	high

TABLE 2: Linguistic and Numeric Values for Security Level

7.2 The priorzed factor resulted from ahp method

The priority of counted factors in security groups, design, familiarity, and competitiveness has been noted in figure 1.

7.3 Rules indicating trust and B2C levels

For refining and finding the rules of fuzzy model, it has been the clustering technique, and the kind of clustering has been chosen the k-means too.
Equation 3 is as a major function in clustering k-means.

$$J = \sum_{j=1}^{k} \sum_{i=1}^{n} \| x_j^{(j)} - c_j \|^2 \qquad (3)$$

All clustering activities were done in SPSS software and the fuzzy rules have been refine from clusters according to table 3.where || || is the criteria of distance between points and cj is the center of jth cluster.

Irshop.ir		Tobuy.ir		Parsim.com	
TRUST	B2C LEVEL	TRUST	B2C LEVEL	TRUST	B2C LEVEL
NUMBER OF RULES		NUMBER OF RULES		NUMBER OF RULES	
23	14	24	15	23	15

TABLE 3: Number of Rules of the Fuzzy System Model Obtained From K-Means Clustering

The rules describing the trust level are based on the degree of security, familiarity, and design that these degrees have been formulated like linguistic variable .similarly, the degree for trust level has been graded from very low to very high in 5 distinctive fuzzy ,collections .these rules have been reached from the users ' answers after ordering ,analyzing ,and clustering .

Table 4 displays the user's preferences for trust level Based on their perceived level of security, design and familiarity.

Rule	Security Level	Familiarity Level	Design Level	Trust Level	
No	Linguistic	Linguistic	Linguistic	Linguistic	Cluster No
1	High	High	High	Very High	2
2	High	High	Moderate	Very High	3
3	High	High	Low	High	12
4	High	Low	High	High	24
5	High	Low	Moderate	Moderate	10
6	High	Low	Low	Moderate	26
7	High	Moderate	High	Very High	18
8	High	Moderate	Moderate	High	19
9	High	Moderate	Low	Moderate	6
10	Low	High	High	Low	27
11	Low	High	Moderate	Low	11
12	Low	High	Low	Very Low	23
13	Low	Low	Moderate	Very Low	25
14	Low	Moderate	High	Low	17
15	Low	Moderate	Low	Very Low	23
16	Low	Moderate	Moderate	Very Low	17
17	Low	Low	Low	Very Low	13
18	Low	Low	High	Very Low	8
19	Moderate	High	High	Moderate	1
20	Moderate	High	Moderate	Moderate	7
21	Moderate	High	Low	Low	9
22	Moderate	Low	High	Low	5
23	Moderate	Low	Moderate	Low	22
24	Moderate	Low	Low	Low	4
25	Moderate	Moderate	High	Moderate	8
26	Moderate	Moderate	Moderate	Low	21
27	Moderate	Moderate	Low	Low	14

TABLE 4: Formation of Trust rules

One of the collection rules of confidence level can be like following:
If (security = high and familiarity = low and design = moderate) then (trust =moderate).
Trust has been shown like a five fuzzy collections, while competitiveness and B2C level has been shown as 3 linguistic variables for fuzzy collection.

One rule of the collection of trust level rules can be like following:
If (trust = low and competitiveness = highly) then (b2c level = moderate).
Totally there are 27 rules for trust that has been created by clustering the user's answers.

Also, the rules of the b2c level are 15 numbers. Table 5 displays the user's preferences for B2C level based on their perceived level of trust and competitiveness. The rules from base of resultant system that consist of 2 separate and relative systems in order that the b2c level is gained despite the security inputs, familiarity inputs, design inputs, and competitiveness level of website.

Rule	Trust level	Competitiveness level	B2C Level	
No	Linguistic	Linguistic	Linguistic	Cluster No
1	High	Low	Low	19
2	High	Moderate	High	9
3	High	Moderate	Moderate	18
4	Low	Low	Low	14
5	Low	Moderate	Moderate	10
6	Low	Moderate	Low	12
7	Moderate	Low	Low	8
8	Moderate	Moderate	Moderate	11
9	Moderate	Moderate	Moderate	1
10	Very High	Low	Moderate	13
11	Very High	Moderate	Very High	26
12	Very High	Moderate	High	3
13	Very Low	Low	Very Low	3
14	Very Low	Moderate	Low	17
15	Very Low	Moderate	Low	4

TABLE 5: Formation of b2c Rules

8. DEVELOPMENT AND ANALYZING FUZZY SYSTEM

8.1 B2c And Trust Levels In The Developed Fuzzy System

After discovering the rules related to trust level, relevant inputs and outputs for earning trust level in fuzzy tool box to be organized and were created relevant membership for input and output . Figure 3 shows the fuzzy system that can be used to derive the trust level.

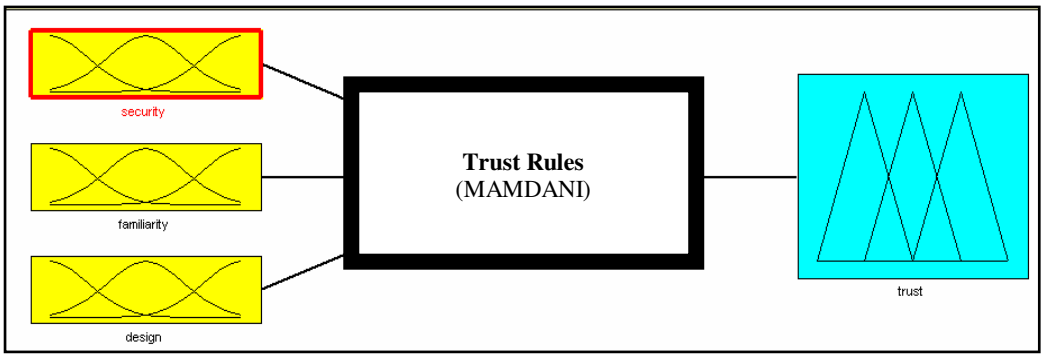

FIGURE 3: Fuzzy system to obtain trust level based on security, familiarity and design inputs

Also after that discovering the rules related to b2c level, relevant inputs and outputs for earning b2c level in fuzzy tool box were organized and were created relevant membership function for input and output. Figure 4 shows the fuzzy system that can be used to derive the b2c level.

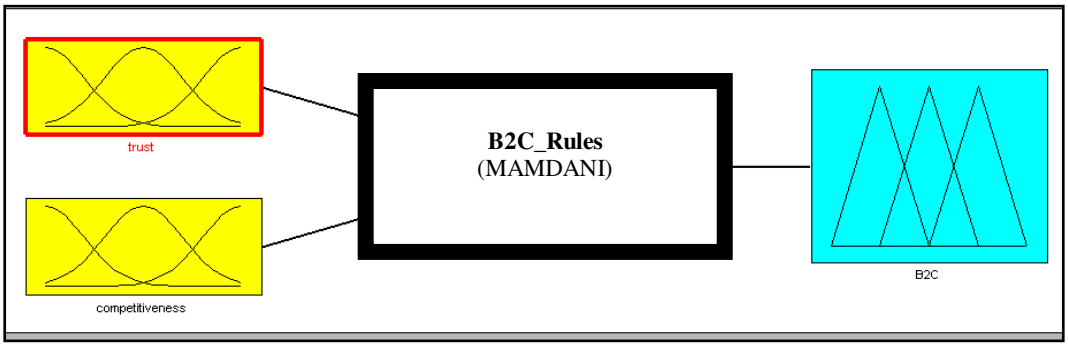

FIGURE 4: Fuzzy system to obtain trust based on trust and competitiveness inputs

8.2 Analysis of Trust versus Security Factor

For complete understanding of participation needed in trust level, it is necessary to separately test the participation of each factor.

The Figure 4 shows contribution to Trust of a given Website originating from the Security. Therefore, the contribution from Familiarity and Design has been kept constant at three levels, namely: low, moderate and high corresponding to numeric values for Familiarity and Design of (1–7 and 15).Figure 5 shows that Trust level is monotonically increasing for increasing perceived security of a website for any given level of Familiarity and Design. However when both F and D is 'High' (numeric value of 15) the Trust level is at its maximum for maximum Security. The three curves have one common feature that they exhibit a 'staircase shaped' curvature.

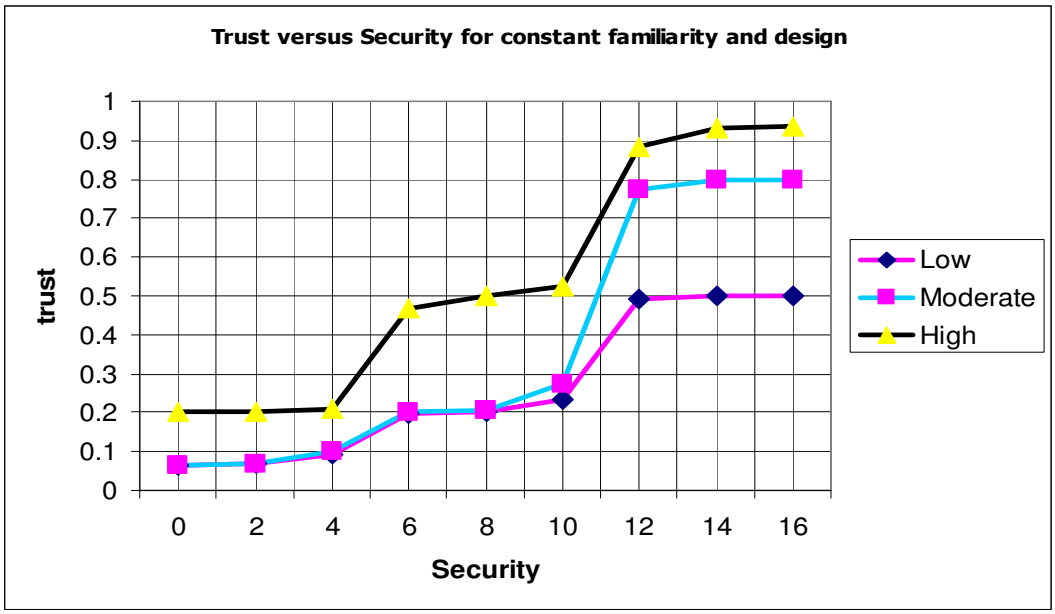

FIGURE 5: Trust versus security factor

8.3 Visualization of trust as function of security and familiarity

We now attempt to visualize the Trust level as a continuous function of its input parameters. Figure 5 Attempts to portray variation of Trust as encapsulated in the rules for Trust. The highest gradient for Trust is when Familiarity is 'moderate' and Security is 'moderate' to 'high'. This suggest that when people are somewhat familiar with a website then a small increase in security levels from between moderate to high security will boost their trust in a significant way. Looking at

Figure 6 diagonally from (low, low) to (high, high) levels of Security and Familiarity one observes three plateaus where the last one is around 0.937, and remains at that level even when the input factors are increased further. This result is somehow unexpected and may be due to the fuzzy nature of the expert system where a 'Trust' or 'Truth' level of 100% is unrealistic.

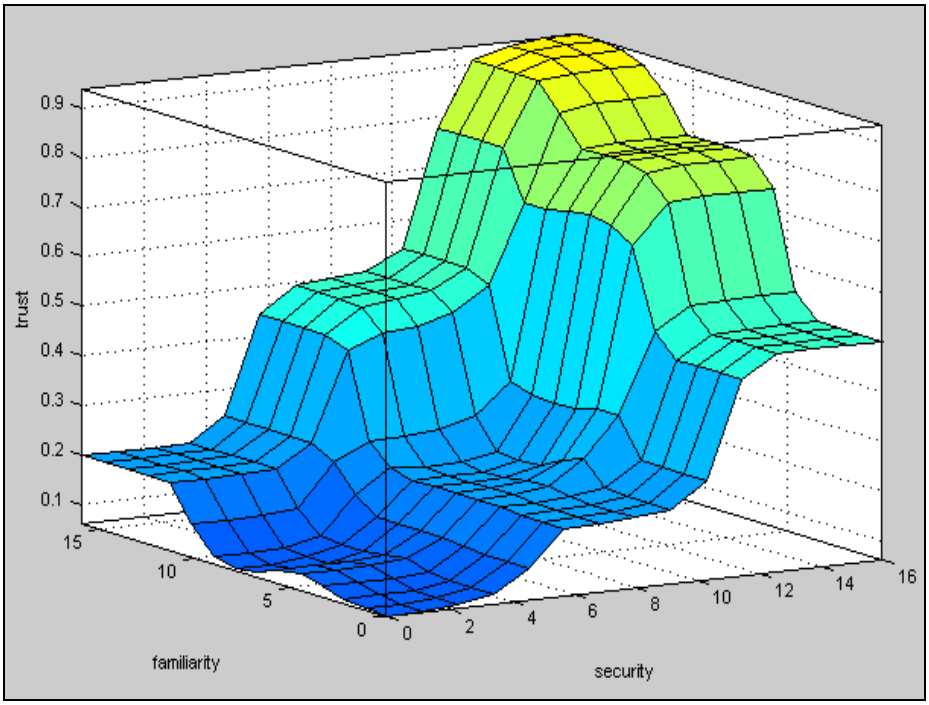

FIGURE 6: Trust level is positively related to levels of security and familiarity.

9. ADVANTAGES OF FUZZY LOGIC FOR TRUST MODEL

The trust relationships among customers and vendors are hard to assess due to the uncertainties involved. Two advantages of using fuzzy-logic to quantify trust in E-commerce applications are:

- Fuzzy inference is capable of quantifying imprecise data and quantifying uncertainty in measuring the trust index of the vendors.
- Fuzzy inference can deal with variable dependencies in the system by decoupling dependable variables.
- fuzzy logic is suitable for trust evaluation as it takes into account the uncertainties within E-commerce data and like human relationships, trust is often expressed by linguistics terms rather than numerical values.

10. CONCLUSION

The e-commerce has given increased choices to consumers due to the growth in the number of online Websites offering products with many variations. In our paper, a tool is defined to assist consumers and vendors to analyze the level of perceived trust in a specific Website.

The consumers can broadly be categorized into two groups, namely those who are technically critical of a site and capable of measuring its security features and those who are not. This survey can be used to step by step follow the instructions and based on actual level of a feature decide its contribution in a category and consequently derive a total value of a factor say Security. Hence the survey can make a buying decision more solid, based on actual appearances of various features. An added advantage would be to feed this data to the FIS for Trust and B2C and the user could compare his/her buying decision with that of others based on the outcome of the fuzzy expert system.

The vendor would benefit from the survey data that is aggregated over time and is used to amend or refine existing rule-sets. Since the data would be accumulated over time the responses would be a blend from both technical and no technical users. Hence the actual occurrence of a feature would be replaced by its perceived equivalence. Since the existence of a feature is only relevant to the user if it can be acknowledged, and if it cannot then the vendor must seriously reconsider inclusion of this aspect on the website.

In addition the vendor can use the survey data to ascertain the Trust level of the site as per user's perception and rectify if needed if this is not obvious or is having a negative impact on the Trust level. Furthermore a measure of the competitiveness is directly deductible from this survey and could be used to retain or increase market share. Lastly as the usage of the survey procedure matures (possibly by providing incentives as discounts on a completed transaction) the Fuzzy Inference Systems could be modified and adjusted where necessary. One limitation of the constructed FIS of this study is that all premises in the antecedent part of a rule have been connected with AND operation where OR operations could also be deployed. The implication and aggregation from the rule would then be significantly different.

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