Implement Fuzzy Logic to Optimize Electronic Business Success

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***Abstract*—Customers are realizing the importance and benefits of shopping online such as convenience, comparison, product research, larger selection, and lower prices. The dynamic nature of e-commerce evokes online businesses to make alterations in their business processes and decisions making to satisfy customers' needs. Online businesses are adopting Business Intelligence (BI) tools and systems with the collaboration of fuzzy logic system to forecast the future of the e-commerce. With the aid of BI, businesses have more possibilities to choose types and structures of required information to serve customers. The fuzzy logic system and BI capabilities would allow both customers and vendors to make right decisions about online shopping. Many experts believe that trust and security are critical risk factors for the embracement of e-commerce. Online trust may be influenced by factors such as usability, familiarity and conducting business with unknown parties. This paper discusses fuzzy logic and BI approach to gauge the level of trust and security in online transactions. The paper further addresses the issues and concerns related to the equilibrium of trust, security, and usability in online shopping.**

Keywords*—Business Intelligence; Fuzzy Logic; Electronic Business; Trust; Security; Usability

I. INTRODUCTION

E-commerce is a widely accepted way of doing business, and within a relatively short time, its services have risen to become a core element of the Internet. The Census Bureau of the Department of Commerce declared that the estimate of U.S. retail e-commerce sales for the fourth quarter of 2015 was $89.1 billion, an increase of 2.1 percent (±0. 9%) since the third quarter of 2015 [1]. E-commerce sales in the USA are projected to reach $482 billion by 2018 [2], accounting for approximately 9% retail sales within the country. The number of digital buyers reached 171 million in 2015 and continues to increase, with the total number of digital buyers projected to surpass 190 million by 2018. Credit and debit cards (73%) are the payment method of choice for USA online shoppers with digital payments (16%) increasing in popularity [2]. The growth of e-commerce is not alone in the US, but the sign points towards continued growth globally. To this end, we aimed at identifying major elements that back the acceptance of e-commerce among the users. This study established the elements that contribute to the growth of users' trust, leading them to complete online retail sales in the United States transactions.

Consumers perceive security threats from different perspectives, for example, whether the web server is owned and operated by a legitimate company, how one can verify that the web pages do not contain malicious code, or how one can ensure that the Web server will not distribute the information to a third party. Similarly, it is important to be able to confirm that the information sent back and forth between the server and the user's browser has not been altered. These concerns illustrate the types of a security issue that can arise in e-commerce transactions. The importance of security implementation is reflected in the policies and actions of the company. Consumers analyze the security policies of vendors mainly through the company's statements on their homepage. These statements normally describe the terms and conditions of the vendor's security policies. For example, through the introduction of security features such as the presence of a secure socket layer, encryption, password and third party security seals. Some companies explain these security policies to alleviate consumers concern while some make these issues hard to find and difficult to understand.

The effectiveness of communicating a commitment to consumers by the use of the latest technology such as third party verification programs, encryption methods, and data protection is important for online companies to appreciate. Previous studies [3] have found no negative correlation between the presence of security statements and the perceived risk of a site. Research also revealed that security statements of Web based companies do show a positive correlation with an increased likelihood that consumers' will purchase from those companies. However, it is not clear during the decision making process, under what conditions the consumer considers security features more important than 'pleasure' features such as convenience, ease of use, and ease of navigation.

An expert has argued that the growth of online e-commerce is attributed not only to ease of use, but also to the fact that they provide reputation and feedback systems that help marketplace platforms create trust [4]. Security features are complex to understand by consumers, but, provided they are properly handled, consumers will confidently conduct their purchase online. Thus, the second hypothesis suggests that the security indicators are the leading factors in the customer's decision to purchase online when compared to design features.

II. LITERATURE REVIEW

An expert has argued that the operational Business Intelligence supports an analysis and control of business processes by an integration of information systems from a technical and business perspective [5]. BI enables the web-

based business to make informed business decisions and thus can be the source of competitive advantages. This advantage is necessary to improve the timeliness and quality of information to serve consumers 'needs. The access to current and accurate information could eliminate the vagueness within a business process. Due to the vagueness and ambiguous information, consumers' find the decision-making process hard and painful. BI would enhance coordination among business process and enable the business to respond timely to consumers' concern and expectations.

Fuzzy logic provides a means for coping with the ambiguity and vagueness that are often present in B2C commerce [4]. Indeed, it was reported that qualitative and fuzzy type information is commonly used in the trust evaluation process [6]. MATLAB was used because of the built-in support that assisted in understanding the intrinsic relationships between the driving parameters and their effects on the degree of B2C transactions in e-commerce. In conclusion, this study has provided a deeper insight into the factors affecting consumer perception of B2C commerce. Nowadays, consumers have many online alternatives to explore and make a sensible and safe purchase decision. They could find the same items offered by different online retailers with different price options in a matter of a couple of clicks. Consumers buying decision could be influenced by different factors such as trustworthiness, brand, reputation, familiarity, third party seal, security and privacy, fulfillment, presentation and many more. Consumers have to analyze and compare these factors to make a final decision of pursuing online transactions. The purpose of research is to uncover hidden relationships between the critical factors and their effect on the human decision process.

The study [7] provides a review of the literature on the trust issue mainly considering organizational level relationships. The review highlights trust evaluation being a multi-layer, multi-criteria and often a context-dependent process which commonly uses various sources of evidence to judge the trustworthiness of trustees. It has been mentioned [8] that trust has been the most important factor for consumers to do business with each other Contrarily, the trustworthiness of a system provides assurance for consumers to choose a particular e-commerce platform in the first place. They have proposed a fuzzy hybrid multi-criteria analysis approach to measure the trustworthiness of e-commerce systems.

It's extremely critical to acknowledge and understand the trust issues that are associated with the websites which hold the customer back from shopping online [9]. They believe that the consumers' concerns have to be acknowledged in respect of security, usability and trust parameters that leads to the development of the fuzzy system. The researchers has [10] presented and discussed a fuzzy logic based reputation system that assessed the consumers and vendors through the exploitation of a fuzzy trust model which takes into account a set of metrics and a fuzzy based reputation aggregation taking into account credibility concept to discriminate false trust values.

III. METHODOLOGY

This study adopts a fuzzy logic approach and utilizes a mathematical research toolset known as Matlab fuzzy logic toolbox® to achieve its objectives. The rationale for choosing the fuzzy logic approach is based on the underlying reasoning process behind B2C transactions, which is based on human decision-making. Though many factors influence the decision process of B2C transactions, 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 to the level of B2C outcome. There may be cases where the inverse is true as well, but for such cases, a high level of persuasion will be needed to alter the perception level.

The concept of a linguistic variable is paramount to fuzzy logic, where values of a linguistic variable are expressed as words rather than numerical values. For example, the statement 'e-commerce successfully implies that the linguistic variable *e-commerce* takes the linguistic value *successful*. The term *rule* in Fuzzy logic, which is the most commonly used types of knowledge representation, can be defined as an IF-THEN structure that relates has given information or facts in the IF part to some action in the THEN part [11]. A rule provides some description of how to solve a problem. The rules are relatively easy to create and understand. Any rule consists of two parts: the IF part, called the *antecedent* (premise or condition) and the THEN part called the consequent (conclusion or action). Furthermore, a rule can have multiple antecedents joined by the keywords AND (conjunction), OR (disjunction) or a combination of both.

Fuzzy reasoning includes two distinct parts: (1) evaluating the rule *antecedent* and (2) implication or applying the result to the *consequent*. In the classical expert system, if the rule antecedent is true, then the consequent is also true. In fuzzy systems, where the antecedent is a fuzzy statement, all rules fire to some extent, or in other words, they fire partially. This can also be understood as that if the premise is true to some degree, then the conclusion will also be true to the same degree. It is required to examine the various hedges of this set, which will automatically create some additional subset of the trust indicators. In order to get a complete picture of the fuzzy expert system, an inference diagram can give a detailed explanation of the processes involved.

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 is the defuzzification process, which provides a numeric value for the likelihood of the B2C transaction, such as how is this system useful to the consumer and what benefits can the B2C vendor expect from utilizing such a tool? For the consumer who is unaware or unable to reach a sound buying decision this tool will assist him/her in understanding the parameters that could influence or

ascertain the strength and weaknesses of the B2C site. Similarly, the B2C vendor can use this tool to discover the critical factors on which consumer bases a B2C transaction irrespective of the product/services offered. Consequently, a more realistic picture can be drawn of the factors influencing a consumer's B2C decision.

IV. Discussion & Analysis

The raw data from the survey has been entered into the worksheet and no interpretation is provided. In the security worksheet, a linguistic input has been assigned a numeric value such as 2, 1 or 0 to calculate the accumulated security level. Accumulated security level is the total sum of the four numeric values and maximum is the percentage of the sum (x/8 multiply by 100). This security level is then calculated as a percentage of a maximum value (usually 8) and from that, a linguistic security level is drawn. It was decided to express the security level as one of three linguistic values, namely low, moderate, and high. The percentage of maximum is evenly distributed to establish a linguistic security level such as low (0-33), moderate (34-66), and high (67-100). The Familiarity worksheet followed the same pattern as used in the security worksheet. The Usability worksheet also followed the same pattern except the linguistic design level was labeled as poor (0-33), moderate (34-66), and good (67-100). In the linguistic data worksheet, trust data have been entered and aligned with security, familiarity, and usability levels by expressing them in terms of linguistic parameters as explained earlier. A Visual Basic language was used to extract and organized data. Trust and other categories are labeled as very low, low, moderate, high, very high and fair, moderate and highly respectively. In the trust rules worksheet, a maximum of twenty-seven unique rules could be identified from respondents input by sorting the security, familiarity and usability columns in alphabetic order. The rules describing the basis for a given trust level were based on degrees of security, familiarity, and usability. These degrees were formulated in terms of their linguistic variables such as low, moderate and high. The degree for usability level was expressed in terms of poor, moderate and good. Similarly, the degree for a trust level was ranging from very low to very high, in five distinct fuzzy sets.

These rules were derived from the survey data after a thorough organization and analysis represent the users' views of the Trust level of a given website based on the given factors. A rule can be extracted such as if (security = high) and (familiarity = low) and (usability = moderate) then (trust = moderate trust). In order to fully understand the contributions from various factors contributing to the Trust level, it is required that we examine the contribution of each factor separately. Figure 1 shows the contribution to Trust of a given website originating from the Security. Therefore, the contribution from Familiarity and Usability has been kept constant at three levels, namely: low, moderate and high corresponding to numeric values for Familiarity and Usability of (1 - 4 and 7). The figure 8 shows that Trust level is monotonically increasing for increasing the perceived security of a website for any given level of Familiarity and Usability (F&U). However, when both F&U is "High" (numeric value of 7) the Trust level is at its maximum for maximum Security. The three curves have one common feature that they exhibit a "staircase shaped" curvature. It is interesting to note that for "low" and "moderate" levels of F&U the developed Trust is almost identical up to a Security level of about 5. Then there is a sharp change on the Trust level between "low" and "moderate", and the perceived Trust for "moderate" F&U is approaching that of "high". A general observation is that the Trust is positively related to Security for any given value of Familiarity and Usability. This observation is also plausible to the human mind. One feature that is disclosed from this figure is that for "high" levels of Security the Trust difference is less significant for "moderate" and "high" levels of F&U. This result could not be anticipated from the outset.

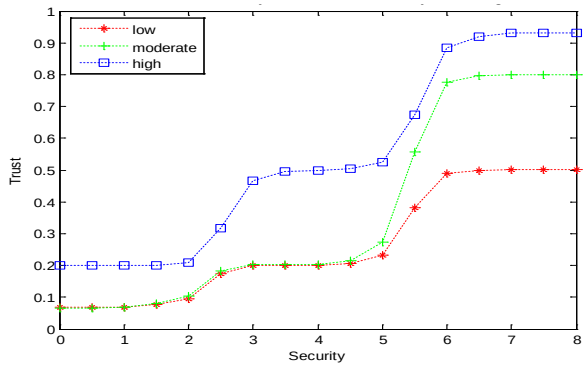

Fig. 1. Trust versus Security for constant familiarity and design

The study has attempted to visualize the Trust level as a continuous function of its input parameters. It should be noted that since the contribution of Familiarity and Usability is identical, it suffices to view Trust as a function of Security and one other factor say Familiarity. The figure 3 attempts to portray variation of Trust as encapsulated in the rules for the Trust.

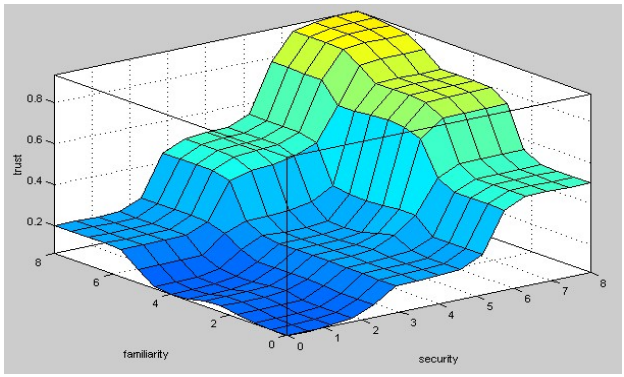

Fig. 2. The trust level is positively related to Levels of Security and Familiarity

The figure 2 shows that Trust level is positively related to Levels of Security and Familiarity. That is when Familiarity and Security are low, then Trust is also low. Furthermore, the Trust is at its maximum when the both Security and Familiarity are maximized. Since the low Familiarity Trust is increasing in "steps" with increasing Security, attaining its maximum at a level of about 0.5. Looking at figure 3 from its topmost point the gradient perpendicular to Security is less than that which is perpendicular to Familiarity axis. This suggests that lowering the Security level has a greater detrimental effect on Trust than

that attained when decreasing Familiarity levels of similar magnitude. The highest gradient for the Trust is when Familiarity is "moderate" and Security is "moderate" to "high". This suggests 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 5 diagonally for (low, low) to (high, high) levels of Security and Familiarity one observes three plateaus where the last one is around 0.925 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. The contributions of Familiarity and Usability levels on Trust are similar and, in fact, identical. This can also be deduced from the figure 3, showing complete mirror symmetry of the Trust mapping. One interesting point to note however is that for maximum Familiarity and Usability the Trust level is never higher than 0.5. This plateau is also reached fairly rapidly with high gradients from both sides of the input variables.

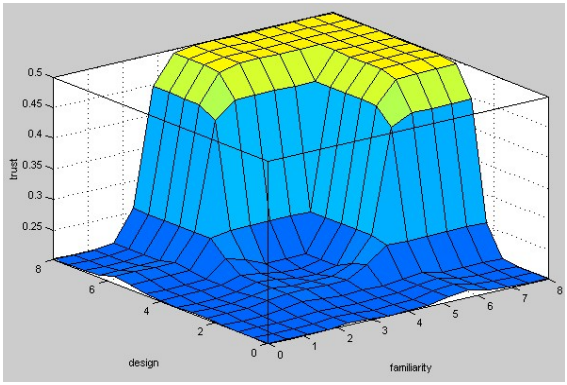

Fig. 3. Mapping of Trust

Consumers generally perceive online shopping as a risky option due to presents of numerous risks. Lack of trust is one of the major risk factors for consumers for not purchasing from online. Security and privacy issues have become an another leading risk factors major for consumers as well business due the growth of the Internet and the complex nature of e-commerce. Strong encryption and authentication are useful in terms of helping to build the trustworthiness of transactions over the Internet but are not yet sufficient for customers to use e-commerce with confidence. Many consumers do not trust an available security option for online transactions and neither trust e-commerce systems, nor believe they will be able to evaluate or control their information when providing them. The issue of trust is very important, especially when the success of e-commerce relies on the profitable exchange of business and consumer relationship.

Fuzzy logic based decision support system, containing BI tools, supports business and organizational decision-making relationship. A properly designed system is an interactive software-based system intended to help consumers' to gauge the level of risk factors in a given website. The proposed system in this study could compile useful information from raw data, documents, personal knowledge, and from business models to create rules to identify the potential risk factors in respect of conducting online transactions. Online business required a current and precision information about the consumers' background, needs and perception of the business process. In this respect, the fuzzy logic approach is capable of collaborating with BI to collect and process the consumers' information. This partnership will assist in creating the rules for making right decisions.

The proposed system is also beneficial to web-based businesses. It allows the businesses to reach out the consumers' possibly by BI. The recommendations and suggestions of the proposed systems would assist the management to address the needs of the customers, ability to act on market drivers, optimization of business and customer retention.

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