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The Analysis of E-Commerce Website Features on Customer's Purchase Intention Using Fuzzy Expert System

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ABSTRACT

The rapid growth of internet users over the past few decades indicates a changing in the business model, in which previously the business only focuses on brick-and-mortar store whereas now, exists a need to add another store named as the e-commerce store. Business-to-Consumer (B2C) e-commerce is one of the various types of e-commerce, which has turned into an influential key to business channel. In order to meet the demands of the current business model, numerous e-commerce websites have been developed. However, building an e-commerce website is not enough if it does not meet the customers'expectation which influences the customers' purchase intention. This study investigates the features of an e-commerce website that influences the customers' purchase intention as well as the most important feature of an e-commerce website based on the customers' perspective. The e-commerce website features that being investigated are website design, information quality, security and privacy which are gained from the literature review. The data is collected through an online survey which consists of 358 respondents who are familiar with purchasing on the e-commerce website. An expert system has been developed by using a fuzzy logic approach to determine which feature possesses the biggest influence on customers in order to perform purchasing on the e-commerce website. The results performed in the MATLAB software shows that

the most significant feature in the e-commerce website is the information quality.

Keywords: *E-commerce, Purchase Intention, B2C Website, Website Features, Fuzzy Expert System.*

1.0 INTRODUCTION

Artificial Neural Networks (ANN) was first introduced by Frank Rosenblatt in 1958. It is called the Perceptron model, a simple model of the biological neuron in ANN. ANN is a processing system, motivated by the biological human brain system. It has a similar function to basic units of the human nervous system that are called "neurons". Each neuron is associated with another neuron which carries weights. ANN consists of many nodes and connecting synapses; each node operates in parallel and connects over the connecting synapses, as shown in Figure 1. For example, the inductive learning process finds out the weights so that the relationship between input and output variables is determined. ANN is trained with examples of datasets without requiring analytical solutions. ANN learns the patterns presented to it. The methods in the process of learning are strictly related to the recommended mathematical form describing the artificial neuron function known as the activation functions. In other words, activation functions are the transfer function of an artificial neuron (Poznyak, Chairez, & Poznyak, 2019). Once they understand the pattern, new patterns may be presented to them for prediction or classification.

Nowadays, e-commerce is a new business model in the world which grows rapidly. E-commerce also prompts a major change in the mode of production and services for the whole world (Elnaga and Al Shammari, 2016). E-commerce is a short form of electronic commerce that can be explained as purchasing and selling of services and goods over the internet (Khan, Khan, and Khan, 2014). An E-commerce website is a platform that can act as a store to receive money through online transactions, receive the order information, and process the delivery of that order. Data obtained from Chaffey (2018) projections show that in 5 years, the retail e-commerce sales will make up to 14.6% of total retail spending. That forecast will increase from USD 1.548 trillion to USD 4.058 trillion from 2015 to 2020. Based on these statistics, it can be said that e-commerce has become a key in business which could mean a modern enterprise competition.

According to Poong, Eze, and Talha (2009), the traditional brick and mortar stores are different from an e-commerce website since there is a separation between customers and web vendor over the internet. Poong, Eze, and Talha said that

e-commerce website also does not allow customers to know whether the web vendor is reliable in doing the business or not. Eventually, these complexities and uncertainties would trigger worries of internet users when they are dealing with online shopping. The authors also added that when customers want to buy products online, they must have a form of mental belief that could reduce complexity and uncertainty. This mental belief is also known as 'trust'. It is believed that the trust developed between the customers and the vendor is the key for the e-commerce business to be successful (Hidayanto et al., 2014).

Therefore, the purpose of this research is to analyze the features on an e-commerce website that influences customers' purchase intention which includes identifying the relevant features related to the customers' trust in e-commerce website and also developing a fuzzy expert system to determine the most significant trust factors in e-commerce websites.

2.0 RELATED WORKS

i. Information quality, online community and trust: A study of antecedents to shoppers' website loyalty
A study which involved 250 respondents conducted by Wang et al. (2009) stated that the information quality provides an important interaction mechanism between customers and websites. Information quality is information content that a website provides to its users. This study also mentioned that information quality is important because consumers can gratify their needs by searching for information online, and they may rely on the information quality on the websites. The perceived information quality leads the customers to believe the website and it provides the websites with positive influences to develop customers' trust in e-commerce.

ii. Key dimensions of business-to-consumer web sites. information & Management
The research from Ranganathan and Ganapathy (2002) discussed the key dimensions of the B2C website found that security and privacy have a great effect on customers' purchase intention. The researcher also mentioned that in order to attract and retain customers to purchase on a website, the website must focus on customers' expectation which is on the issues of security and privacy on a website.

iii. The effects of website design on customer trust in e-commerce
Coles (2010) who studied the effects of website design on customers' trust in e-commerce stated that website design has a positive correlation with customers' trust in e-commerce. Website design is a process of creating a website that focuses

on aesthetic factors like webpage layout, content production, and graphic design in order to make the website more visually appealing and easy to use. Coles stated that website design draws customers' first impressions and the sense of the initial level of trustworthiness and can be developed into a stronger level of trust. In this research, websites that include the privacy statement and buyer testimonials in their design have a higher significant value of trust based on the customers' perspective.

iv. A fuzzy logic analysis of e-commerce website quality factors for customers' purchase intention.

Rad, Nilashi, and Ibrahim (2017) conducted a research on the analysis of an e-commerce website by using the fuzzy logic approach to determine the quality factor for customers' purchase intention. An evaluation obtained from the trust factor consists of perceived security, perceived privacy and information quality. In this study, the researchers used fuzzy logic due to the availability to evaluate qualitative information which is related to human opinion, perception, and taste. As a result, it is easier to develop an assessment tool for customers' trust based on websites' features to improve the intention of purchasing on an e-commerce website.

3.0 METHODOLOGY

In this research, primary data was collected through a questionnaire created by using Google form and was distributed through social media. The data received were filtered before being used to formulate the model. The data can only be accepted if the respondents have spent more than 4 times on an e-commerce website to ensure that the respondents are familiar with purchasing through an e-commerce website. The fuzzy logic approach was used in developing the expert system which evaluated the features of B2C websites and determined their importance levels. In order to evaluate the trust factor of the e-commerce website, MATLAB software was used to apply the fuzzy system.

This research used the fuzzy logic approach which consists of two concepts for the fuzzy system design. The first one was the linguistic variable and another one was a fuzzy IF-THEN rule base. In this system, the important part was the decision making where the Fuzzy Inference Systems (FIS) was applied. FIS is a mechanism for evaluating the fuzzy system which computes output values from the input values. Basically, FIS formulates suitable rules for decision making. There are three components of the fuzzy system design which are fuzzification, fuzzy inference, and defuzzification. The structure of the fuzzy system is shown in
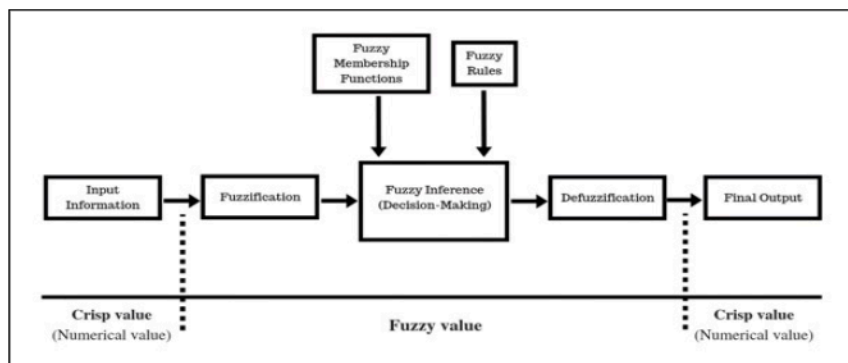
the following Figure 1.

Figure 1: Structure of a fuzzy system

In this research, two types of membership functions will be inspected which are Gaussian membership function and triangular membership function as shown in Table 1. In fuzzification, the input membership functions were used while for defuzzification, the output membership function was used. Note that Gaussian and Triangular membership functions are common in a fuzzy logic system.

Table 1: Information of membership functions for input and output in the fuzzy model.

	Variables	Types of membership function
Inputs	Website Design	Gaussian
	Information Quality	Gaussian
	Security	Gaussian
	Privacy	Gaussian
Output	Important Level of Features	Triangular

i. Fuzzification
Fuzzification is a process of changing a real scalar value into a fuzzy value. A fuzzification is used to find the level of membership for each value in a set of values of inputs. For the Gaussian membership function with bell-shape, it can be defined as below

$$f(x, c, \sigma) = e^{-\frac{(x-c)^2}{2\sigma^2}}$$

In the above equation, x is the input variable, c stands for centre while σ is the

width. Fuzzy sets consist of a linguistic form and membership value. The following linguistic variables for all input variables were used and shown in Table 2.

Table 2: Fuzzy set input of e-commerce features

Linguistic variables	Symbols
Low	L
Moderate	M
High	H

ii. Fuzzy Inference
The fuzzy inference rules are used in the inference process in order to relate the input and output membership functions. The inference engine consists of a knowledge base and rules, which are important to generate the output. In order to formulate the conditional statements that consist of the fuzzy logic, "IF-THEN" statements are used in the linguistic rules. A fuzzy rule is a simple IF-THEN rule that has a condition and a conclusion. The methods used in the FIS is Mamdani method since this study is related to the interpretation of humans' perception, the Mamdani modelling is used to determine the output membership function for each rule. The Mamdani is based on the following structure:

$$\text{IF } x_1 \text{ is } A_{i1} \text{ and } x_2 \text{ is } A_{i2} \text{ ....and } x_n \text{ is } A_{in}, \text{ THEN } y \text{ is } C_i \tag{2}$$

where x_j ($j = 1,2,..., n$) are the input variables, y is the output variable and Ain and Ci are fuzzy sets for xjand y, respectively.

In this research, the fuzzy rules were obtained by extracting the responses of the respondents. The extracted responses were obtained from the Likert-based questionnaire that had been designed based on the four important features on the e-commerce website. For this research, there were four inputs with three linguistic expressions and one output with five linguistic expressions. From the 4 main features, a total of 12 sub-features, where each main feature contains 3 sub-features, had been collected based on the data from 358 respondents. Table 3 shows the main features and the sub-features used in the expert assessment system.

Table 3: Main features and sub-features used in the expert assessment system

	Main Features	Sub-features	Reference
Input	Website Design	1. This website has visually and well-organized appearance. 2. This website provides buyer testimonials. 3. This website displays privacy and security statement.	Coles, 2010
	Information Quality	1. This website provides accurate information on the item. 2. This website provides reliable information. 3. This website provides sufficient information during transaction.	Wang, Wang, Cheng and Chen, 2009
	Security	1. This website is safe for personal information. 2. This website protects transactions information. 3. This website does not use customers' information for other purposes without customers' authorization.	Ranganathan and Ganapathy, 2002
	Privacy	1. This website protects information on customers' web behaviour. 2. This website does not share customers' information with other websites. 3. This website protects customers' credit card information.	Norjihan and Zailani, 2009
Output	Importance level of features		

The data collected from this group was used in the FIS of the fuzzy logic-based assessment model. In order to determine the output membership functions for each rule, Mamdani modelling was used for the fuzzy inference and fuzzy decision-making.

iii. Defuzzification

Defuzzification is a process of transforming the fuzzy output into a crisp output. The most common defuzzification method is a centroid method since it can be applied for any type of fuzzy sets. Centroid method is also known as the centre of the area and the formula for the centroid method is given below

$$z = \frac{\int \mu_c(x).x dx}{\int \mu_c(x) dx}$$

where z is the crisp output, μ_c is the aggregated membership function while x is the output variable. All the units established in the implementation phase are integrated into a system after each unit is tested. The results of the defuzzification step are then used to reveal the importance level of B2C websites' features. For the triangular membership function with straight lines, it can be defined as below

$$f(x,a,b,c) = \begin{cases} 0, & x < a, x > c \\ \frac{x-a}{b-a}, & a \le x \le b \\ \frac{c-x}{c-b}, & b \le x \le c \end{cases}$$

The output variable is assigned with the triangular membership function, defined by a lower limit a, an upper limit c, and a value b, where a<b<c. Table 4 shows the linguistic variables for the output variables used.

Table 4: Fuzzy set output of degree of the customers' perceptions of e-commerce features

Linguistic variables	Symbols
Very Low	VLow
Low	Low
Moderate	Moderate
High	High
Very High	VHigh

4.0 RESULT AND DISCUSSION

Result from Extracted Rules base

From the responses of the 358 respondents, only 22 rules base were generated. The extracted rules base was taken from the analysis of the responses in the questionnaire. These were 3 main steps taken before obtaining the extracted rules base:

1.   Determine the updated linguistic variables.
2.   Combine the input and the output variables to form a rule base.
3.   Select rules base according to the highest number selected by the respondents.

The method used to obtain the updated linguistic variable was mode formula. If the mode formula fails, then the average formula would be used. When the first step is completed, each respondent has 4 input linguistic variables which indicated each main feature. The second step was to combine the input and the output variable to form an "IF-THEN" rule base. The last step, which is choosing the rules base, depends on the higher number selected by the respondents. Since there were 358 respondents, there had to be 358 rules base because each respondent has his or her own rules base. From 358 rules base, similar rules base did exist. However, the rules base that needs to be inserted in FIS must be a unique combination of input linguistic variables. Therefore, the higher selected output for that rules base is

chosen. From a total of 358 respondents, only 22 unique rules base were generated. Table 5 show the unique rules base that generated.

Table 5: Extracted rules base

Rule	IF WD	AND IQ	AND S	AND P	THEN Trust Level
1	H	H	H	H	VHigh
2	H	H	H	M	High
3	H	H	M	H	High
4	H	H	M	M	Moderate
5	H	M	H	H	High
6	H	M	H	M	Moderate
7	H	M	M	H	High
8	H	M	M	M	Moderate
9	H	M	M	L	Moderate
10	H	L	H	H	High
11	M	H	H	H	Moderate
12	M	H	H	M	Moderate
13	M	H	M	H	High
14	M	H	M	M	High
15	M	M	H	H	High
16	M	M	H	M	Moderate
17	M	M	M	H	Moderate
18	M	M	M	M	Moderate
19	M	M	L	H	Moderate
20	M	M	L	M	Moderate
21	M	L	H	M	Low
22	L	M	H	M	High

(WD=website design, IQ=information quality, S=security, P=privacy)

Overall Evaluation of the Features of the Trust Level

From the combination of the inputs and the outputs of extracted rules base shown in Table 5, a correlation between the input and the output can be obtained in 2-D curves by using MATLAB software. The illustration of the relationship between input and output is essential in explaining the importance of the level of the features of e-commerce websites. Figure 2, 3, 4 and 5 represent the interdependency of trust and four main features through the curves obtained from the fuzzy rules generated from the data. The curves represent the variation of trust based on discovered rules. These curves indicate the trust level versus the importance level of each feature of the website.
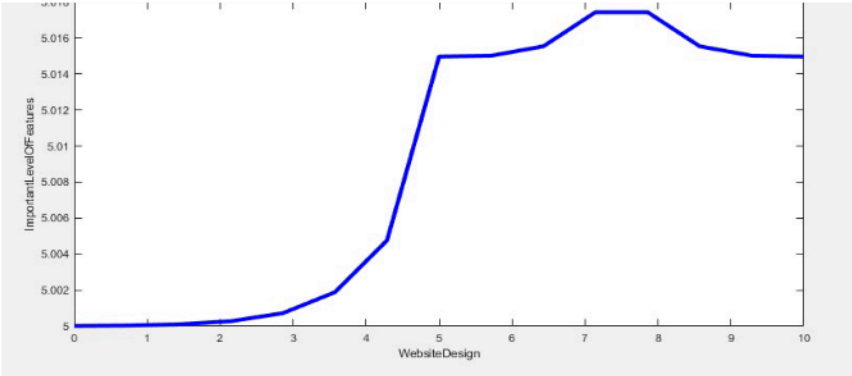
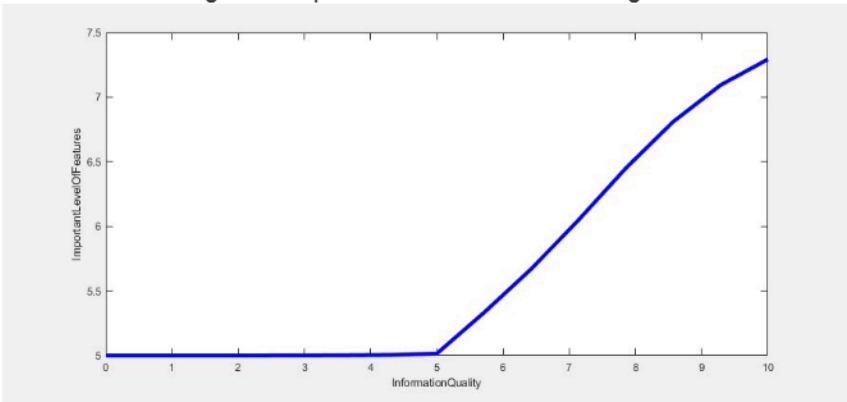257

Figure 2: Importance level of website design.

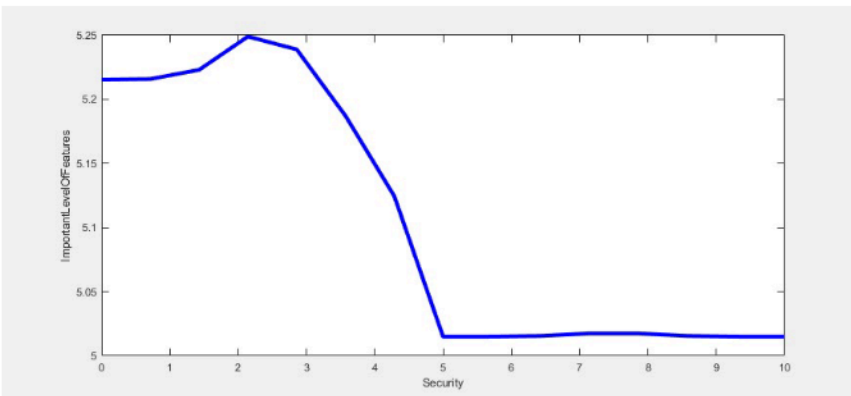Figure 3: Importance level of information quality.

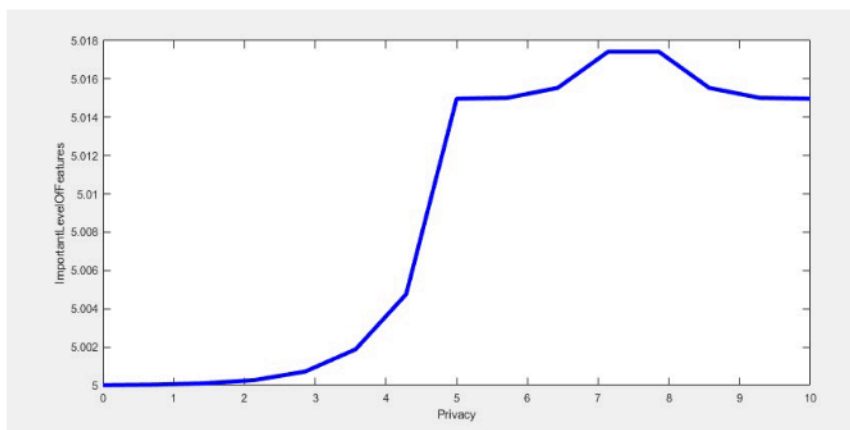**Figure 4: Importance level of security.**

Figure 5: Importance level of privacy.

It can be said that evaluating the features of e-commerce websites can be effectively modelled by using fuzzy inference systems based on the customers' knowledge regarding the features of e-commerce websites, which is formed as fuzzy logic. Table 6 shows the maximum weights of all the features of e-commerce websites.

Table 6: Final assessment weight for the features of B2C websites.

Features	Maximum Weight
Website Design	5.017
Information Quality	7.25
Security	5.25
Privacy	5.017

By viewing the curves and discovering the fuzzy rules, it can be stated that trust is more affected by the information quality compared to security, and lastly followed by the website design and privacy. It shows that a website containing satisfying information quality for its customers increases the intention of the customer to purchase through the website compared to the other features. However, the result is inconsistent with past studies (Rad, Nilashi, and Ibrahim, 2017) where security represented the most significant effect on trust while the result of this study shows that information quality is the most important feature that customers observe before deciding to purchase through an e-commerce website. This difference may be due to the factors such as the sample size, different categories of respondents and number of main features that investigated which were security, privacy and information quality while this study added an extra feature to be investigated as well, which is the website design.

5.0 CONCLUSIONS

An effort was made in this study to develop an expert system using the fuzzy logic approach to determine the significant features in the e-commerce website. These significant features can influence customers' purchasing intention. The features of e-commerce websites related to the customers' trust, namely website design, information quality, security and privacy were selected from the literature. These four features achieved the first objective of this study which is identifying the relevant factor related to the customers' trust in an e-commerce website.

In order to evaluate the four features, an assessment system based on fuzzy logic was developed with its FIS. In the FIS model, all the input variables used the gaussian membership functions while for the output model, triangular membership functions were considered. The extracted rules base was discovered to be used in the FIS. The results of the expert system showed that the fuzzy logic was able to evaluate the features of e-commerce websites. Result also showed that the customers' trust was more influenced by information quality compared to the other features with a maximum level of about 7.25.

REFERENCES

Chaffey, D. (2018). Forecast growth in percentage of online retail / Ecommerce sales. https://www.smartinsights.com/digital-marketing-strategy/online-retail-sales-growth/

Coles, G. M. (2010). The effects of website design on customer trust in e-commerce. http://infotech.scu.edu.au/wsmart/documents/George_Thesis_Final.pdf

Elnaga, A. A., & Al Shammari, F. H. (2016). The impact of e-commerce on business strategy: A literature review approach. Journal of American Science, 12(5), 68-79.

Hidayanto, A. N., Herbowo, A., Budi, N. F. A., &Sucahyo, Y. G. (2014). Determinant of customer trust on e-commerce and its impact to purchase and word of mouth intention: A case of Indonesia. Journal of Computer Science. 10(12), 2395-2407.

Khan, M. D., Khan, F., & Khan, M. E. (2014). Growing importance of e-commerce in global market. International Journal of Management Sciences, Research Academy of Social Sciences, 3(3), 147-151.

Norjihan, A. G., &Zailani, M. S. (2009). Personal Information Privacy Protection in E-commerce. WSEAS Transactions on Information Sciesces and Application, 3(6), 407-416.

Poong , Y.-S., Eze, U. C., & Talha, M. (2009). B2C e-commerce in Malaysia: Perceived Characteristics of Innovating and trust perspective. International Journal of Electronic Business, 7(4), 392-427.

Rad, M. S., Nilashi, M., & Ibrahim, O. (2017). A fuzzy logic analysis of e-commerce website quality factors for customers' purchase intention. Journal of soft computing and decision support system, 4(2).

Ranganathan, C., & Ganapathy, S. (2002). Key dimensions of business-to-consumer web sites. Information & Management, 39(6), 457-465.

Wang, M. C.-H., Wang, E. S.-T., Cheng, J. M.-S., & Chen, A. F.-L. (2009). Information quality, online community and trust: A study of antecedents to shoppers' website loyalty. Int. J. Electronic Marketing and Retailing, 2(3), 203-217.