Research Article

Fuzzy-Based Trust Model to Evaluate Customer Trust towards Online SNSs Sellers

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Abstract: The rapid growth of Social Networking Sites (SNSs) as business platforms for individual or small sellers recognised trust as the main important role in determining the successful execution of their business operation.Current trust modelfocused in business sellers by considering website as one of the trust factors. However, these model are not applicable for SNSs environment. Based on the identified factors affecting trust in SNSs environment, this paper proposeda fuzzy-based trust model to evaluate customers' trust based on their perception and experiences.The evaluation model was then tested to validate its efficiency in evaluating trust level.

Keywords: Customer's trust; SNSs; Fuzzy Logic; Trust Evaluation Model

1. Introduction

The Social Networking Sites (SNSs) are a kind of disruptive technology for communication that has gone beyond conventional means of social interaction (Noordin *et al.*, 2018). Amid its usage mainly for communication, a new concept has been drawn out of SNSs which leveraging its features for another form of E-Commerce model that supports buying and selling both physical and non-physical items (Mohamad *et al.*, 2017), known as social commerce (K. Z. K. Zhang and Benyoucef, 2016). Until recently, the development of Social Network Sites (SNSs) fosters opportunities for individual and small sellers to establish their businesses. Although the SNSs are not designed originally for business purposes, the platform allows important commercial activities between buyers and sellers such as business transactions and interactions (Leung, Shi, and Chow, 2019). The arises of popular SNSs such as Facebook, Instagram, and Twitter have changed the way enterprises operate their business from physical shops to the virtual environment. The reinforcement of 2.0 technologies within the platform have positively yield advantages for sellers, including the establishment of relationships with customers and build their reputation and branding (Clark *et al.*, 2017). On the other hand, customers could gain benefits in helping them in decision making for online purchases by reading the content generated by peers and sellers themselves such as reviews and ratings, a more reliable source of information than traditional media (Wang and Yu, 2017). The superiority of the technologies enables customers to interact on product price, payment method, shipment, or even for bargaining.

Despite the growth of SNSs exploitation as business platforms, trust remains as the barrier for the sellers, and the need for it is exceptional (Lee, 2016). The potential problems such as fraud and scam are persuasive due to lack of visibility, lack of law enforcement and inability to experience the products directly (Riefa, 2019). Majority of the study on trust focus on business sellers (B2C) where businesses sell products to consumers with the aid of user ratings and reviews (Hawkins, 2019). This is due to the development of business models and technologies shift is not parallel with the enforcement of consumer law, particularly for individual businesses who are sellers and consumers (i.e., C2C) at the same time over SNSs. Little studies focus on C2C on SNSs despite the growing concern towards trust, resulting customers having less trust toward individual sellers than toward large established firms (Wongkitrungrueng and Assarut, 2018).

The increasing number of cases of scams reported by the Australian Competition and Consumer Commission shows that consumers in that country have lost over $500 thousands in 2019 to scams on online shopping via social media platforms (Australia Competition and Consumer Comission, 2019). This statistic reveals that transactions via SNSs are prone to risks and the current law enforcement is inadequate in protecting consumers (Lee, 2016; Riefa, 2019).

In the context of online shopping or E-commerce in a more broad term, trust between users (i.e., buyers and sellers) is one of the success factors during the commencement of transactions (Alarfaj, Solaiman, and Marshall, 2019). Fundamentally, it is a significant consideration of buying intention or prior to making decisions for where both of them are geographically dispersed (Hillman *et al.*, 2012). When buyers search for products or services

that suit their needs over SNSs, typically they inclined to find credible information, and it possibly reduces the concerns when making decisions (Gvili, Kol, and Levy, 2019).

The concepts of trust is considered as subjective decision making as it involves uncertainties. As trust is often expressed in linguistic terms rather than numerical, fuzzy logic is possible approach as it takes into accounts the vagueness and ambiguity issues.Few studies have been proposed trust evaluation model for B2C (Meziane and Nefti, 2007; Anurag and Aggarwal, 2014; Hussain 2018; Kaur and Madan, 2014) and C2C(J. Zhang and Guo, 2009)using fuzzy logic approach. However, these models are not suitable to evaluate individual and small sellers that used SNSs as their business platform. Therefore, there is a need to develop a model that allows customers to express their perception when dealing with this type of sellers.

In order to overcome the issues, this study proposed a trust evaluation model based on customers' perception. Fuzzy logic approach applied to handle uncertainty in evaluating and quantifying the trust model. Proposed model is then validated with experts which is SNSs users who have experienced in performing transaction with online SNSs sellers. Result from the validation will indicates the accuracy and effectiveness of the proposed model.

2. Fuzzy Based Trust Model

The fuzzy logic assessment model is implemented based on Mamdani Algorithm. Mamdani-type is chosen because it is the most used method to represent a decision processes. The proposed model consists of two levelsIn the first layer, the model will assess the inputs for each modules. Based on the levels obtained in first layer, the trust level is then evaluated in the second level that consists of the four modules which is Electronic-Word of Mouth (E-WoM), Social Commerce Construct, Information Quality and People. The model is proposed based on previous studies conducted (Ramli and Bakar, 2018).

For the inputs, three membership functions labelled as Poor, Average and Good will be used for each of the indicators. Output membership which is the trust level also use three membership function labelled as Low, Moderate and High. The three membership values of inputs and output represents the similar way how human express their judgement during the evaluation(Nilashi *et al.*, 2015).Meanwhile, the triangular type of membership function is chosen to simplify the computation. Table 1 and Table 2 present the membership function for inputs and output respectively.

Table 1. Membership function for inputs

Module	Inputs	Linguistic terms		
		Poor	Average	Good
E-WoM	Positive Valence	[-0.42 0 0.42]	[0.08 0.5 0.92]	[0.58 1 1.42]
	Negative Valence	[-0.42 0 0.42]	[0.08 0.5 0.92]	[0.58 1 1.42]
	E-WoM Content	[-0.42 0 0.42]	[0.08 0.5 0.92]	[0.58 1 1.42]
Social Commerce Constructs	Recommendation	[-0.42 0 0.42]	[0.08 0.5 0.92]	[0.58 1 1.42]
	Rating	[-0.42 0 0.42]	[0.08 0.5 0.92]	[0.58 1 1.42]
Information Quality	Accuracy	[-0.42 0 0.42]	[0.08 0.5 0.92]	[0.58 1 1.42]
	Completeness	[-0.42 0 0.42]	[0.08 0.5 0.92]	[0.58 1 1.42]
	Currency	[-0.42 0 0.42]	[0.08 0.5 0.92]	[0.58 1 1.42]
	Understandability	[-0.42 0 0.42]	[0.08 0.5 0.92]	[0.58 1 1.42]
People	Transaction Safety	[-0.42 0 0.42]	[0.08 0.5 0.92]	[0.58 1 1.42]
	Reputation	[-0.42 0 0.42]	[0.08 0.5 0.92]	[0.58 1 1.42]
	Propensity to Trust	[-0.42 0 0.42]	[0.08 0.5 0.92]	[0.58 1 1.42]

Table 2. Membership function for outputs

Output	Linguistic terms		
	Low	Moderate	High
Trust	[-0.42 0 0.42]	[0.08 0.5 0.92]	[0.58 1 1.42]

3. Formation of Fuzzy Rules

A questionnaire was designed toform the rules for the fuzzy logic assessment model. The questionnaire consists of 13 questions related to each of the inputs and 1 question to determine the customers' trust level towards three online SNSs sellers. Linguistic scaleswhich range from 0 to 2 used by the 216 respondents to express their evaluation towards the online SNSs sellers based on the parameters given.

K-mean techniques was applied to cluster the collected data for the purpose of rules formation. Number of rules needed depends on the number of membership functions. Table 3 presented number of rules formed for this study.

The fuzzy inference system(FIS) for each model was implemented using fuzzy logic toolbox using MATLAB software. The centroid of area (COA) method was used for defuzzification purpose. The results of defuzzification were then used to determine the trust level of online SNSs sellers. Results for each rule was derived using MIN operator. Results from each rule were then aggregated using MAX operator to generate the overall results. The combination of both input memberships, output memberships with the rules presented in Table 4.

Table 3. Formation of rules

Input	Output	Number of Fuzzy Rules
Positive Valence Negative Valence E-WoM Content	E-WoM	3*3*3 = 27
Recommendation Rating	Social Commerce Constructs	3*3 = 9
Accuracy Completeness Currency Understandability	Information Quality	3 *3 *3*3 = 81
Transaction Safety Reputation Propensity to Trust	People	3*3*3 = 27
E-WoM Social Commerce Constructs Information Quality People	Trust	3 *3 *3*3 = 81
	Total number of Fuzzy Rules	225

Table 4. Fuzzy Rules for Trust Evaluation

	EW	**SCC**	**IQ**	**PEOPLE**	**TRUST**
1	Good	Good	Good	Good	High
2	Good	Good	Good	Average	Moderate
3	Good	Good	Good	Poor	High
4	Good	Good	Average	Good	High
5	Good	Good	Average	Average	Moderate
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
77	Poor	Poor	Average	Average	Low
78	Poor	Poor	Average	Poor	Moderate
79	Poor	Poor	Poor	Good	Low
80	Poor	Poor	Poor	Average	Moderate
81	Poor	Poor	Poor	Poor	Low

Figure 1 illustrates 3-dimensional plots and curves to present the interdependency of trust and four modules obtained from the generated rules. SCC and IQ influences trust more than EW. In both combination pairs, EW has no influence on trust (Figure 1a and Figure 1b). Figure 1c shows that IQ and PEOPLE influences the trust approximately to the same extent. This combination pair has highest influence on moderate trust level. The same findings applies to IQ and SCC in Figure 1d. Meanwhile, Figure 1e and figure 1f IQ depicts that IQ, SCC and PEOPLE have strong influences to trust.

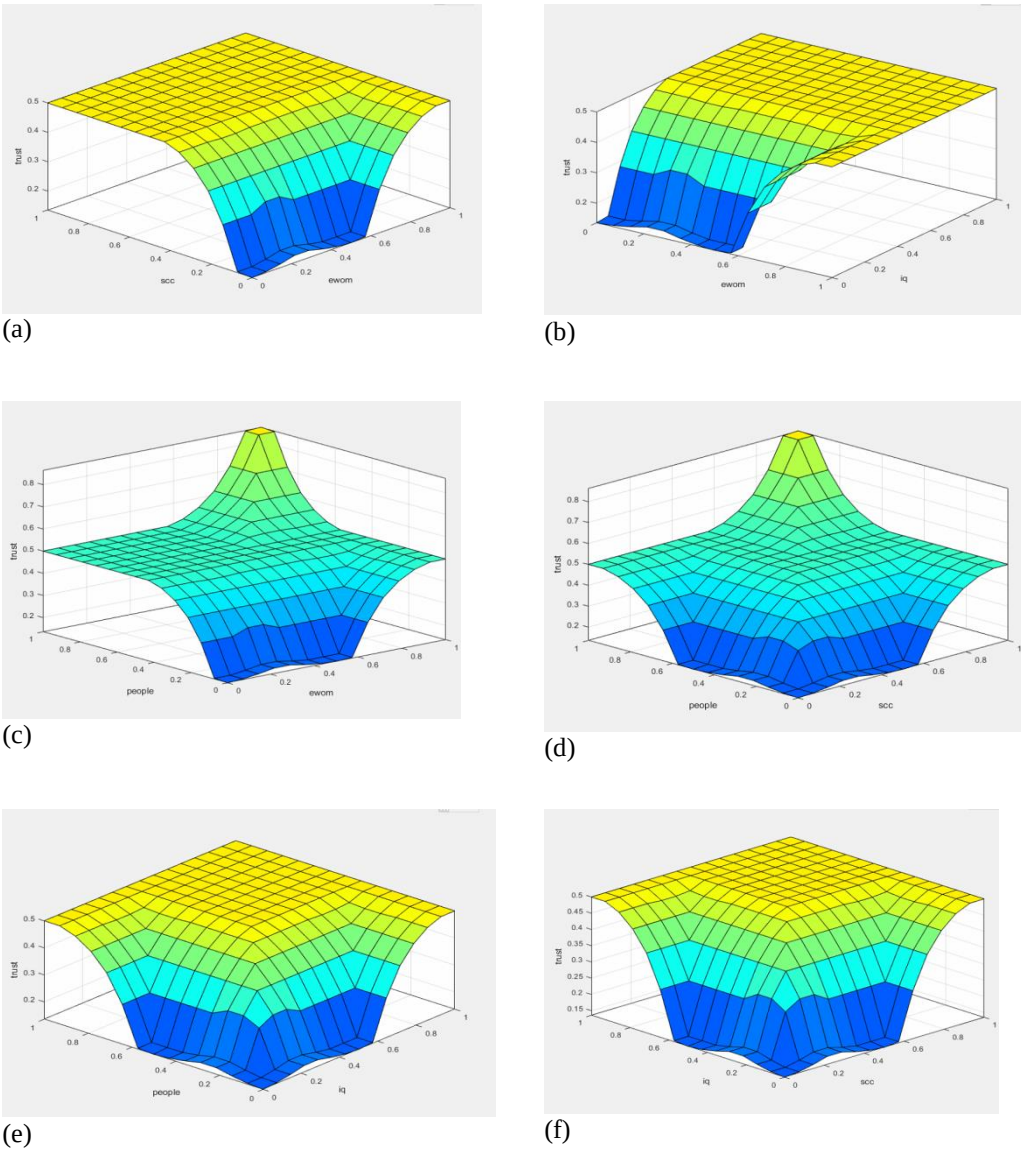

Figure 1.3-dimensional Plots

4. Simulation of Fuzzy Logic Controller

For the purpose of simulation, Fuzzy Logic Controller (FLC) was implemented using Simulink. The FLC is a FIS integrates with rule viewer. Figure 2 shows the Simulink block diagram for the trust evaluation. The block diagram consists of five Fuzzy Logic Controller with Rule Viewer blocks, 13 constant block, five multiplexer blocks and a display window for output. After the simulation completed, the diagnosis appears in the display window along with its membership function. The membership functions displayed were mapped with the trust level adapted from Anurag (2014)Hussain (2017) and Kaur (2014)as shown in Table 5. From figure 2, the trust values of 0.6176 is considered as high. Therefore, the trustworthiness of online SNSs sellers were considered as very trustable and reliable.

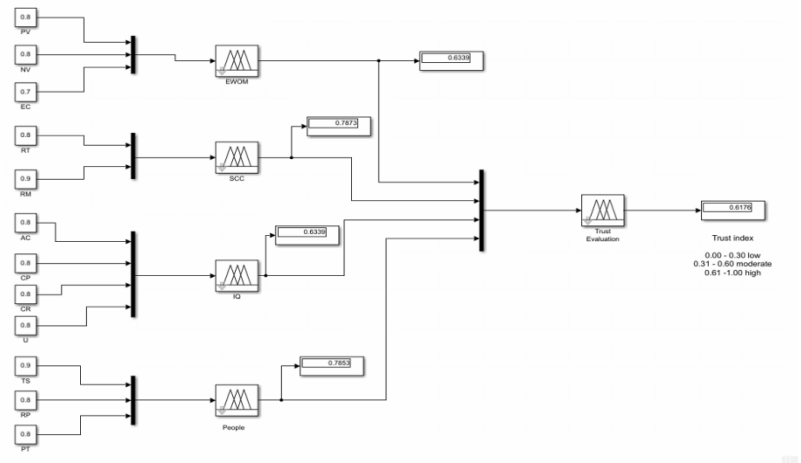

Figure 2. Simulink Block Diagram

Table 5. Trust values with corresponding trust level

Trust Value	Trust Level
0.30	Low
0.31-0.60	Moderate
0.61 – 1.00	High

5. Validation Of The Fuzzy Based Model

For validation, a case study was conducted with 119 respondents using the previously design questionnaire. The respondents were asked to perform their evaluation for a chosen online SNSs seller. Using the developed fuzzy assessment model, accuracy test was conducted to compare the results from the model with respondents' evaluation. The accuracy of the evaluation was calculated using the formula in (1)

$$Accuracy = \frac{n}{N} X100 \qquad [1]$$

Where *n* is the number of correct evaluation and *N* is the total number of respondents involved.

Based on the results in Table 6, out of 113 data evaluated correctly by the developed fuzzy model. This shows that the evaluation results obtained 95% accuracy compared to the respondents' evaluation. Results of this study shows that the developed model is feasible in evaluating online SNSs sellers.

Table 6. Evaluation results

	# respondents	# correct evaluation	# incorrect evaluation	Accuracy
Fuzzy Model	119	113	6	95%

6. Conclusion

This study proposed a fuzzy-based model to evaluate the trustworthiness of online SNSs sellers from the customers' perception. The developed model evaluates three modules with 13 indicators as inputs. For the evaluation purpose, the model used Mamdani's max-min fuzzy inference methods using the MATLAB software. Total of 225 rules were generated to reveal the customers' trust level. Simulink was used to simulate the evaluation. In order to determine the accuracy of the developed model, the output produced were compared with the respondents who have experience with online SNSs sellers. The accuracy results present that this model are capable in assisting customers to evaluate the trustworthiness of Online SNSs Sellers based on their perceptions and experiences.

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