

A Trust Based Assessment Model for Evaluating Trust Performance in E-commerce

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ABSTRACT

Ecommerce penetration is becoming more robust as a result of wider coverage of internet facilities. Trust remains a major factor in an online business environment because user feels vulnerable to cybercrime and customers are sceptical in disclosing their personal details for the fear of the information not being used for the intended purpose. Also, there is need to be able to assess the trust performance between vendors and customers in e-commerce environment. This work investigates the issue of trust between merchant and consumer on ecommerce and also characterizes the different types of trust that exists between both parties. The main parameters for measuring the trust are based on customer satisfaction which is further broken down to Timely Service Delivery, Constant Service Delivery, Quality of Product, Pricing, Privacy Policy and Returns Policy. This research presented a model based on a linear mathematical model and fuzzy logic approach using Sugeno inference fuzzy system. This approach was applied to an Ecommerce model to assess and evaluate trust performance of customers using feedback system from shopping experience. This proposed model uses a linear mathematical model in measuring the level of trust between the merchant and customer and further uses the concept of fuzzy logic in evaluating the trustworthiness using Sugeno Fuzzy Inference System where the trust parameters serves as the matrices for performance evaluation as the results will be derived using a crisp value for the trust level.

Keywords: E-commerce, Trust, fuzzy logic, Sugeno inference, Customer satisfaction.

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1. BACKGROUND TO THE STUDY

Trust has become a big factor and every conversation or transaction that occurs on an ecommerce page is as a result of trust which serves as more reason a buyer decides to visit a seller page (Paolo Guenzi *et al.*, 2009). As described, trust is the confidence a buyer has in the seller based on patronage, customer relation and so on. It has become a very important issue in e-commerce as a result of the high risk factors such as impersonation, fraud, security, privacy, and page-jacking and so on associated to the environment and digital processes.

According to Industry Analyst, trust and security has been seen as important barriers to preventing in the growth of e-commerce, also, research has established that 69 percent of online users did not provide information on web sites because the sites did not provide any information on how the data would be used and also are concerned about “identity theft” if their personal information were not used for the intended purpose or leaked to unauthorized individuals or organizations (Kusumadewi *et al.*, 2013).

1.1 Statement of Problem

Trust is important wherever risk, uncertainty, or interdependence exists because without trust, e-commerce will not be a success and it is one of the most desired qualities in any close relationship which may lead to significant benefits especially in business relationships. Buyers are looking for quality product at a reasonable price and seller wants to sell their product and to be well known in the marketplace. In fact, a buyer could be a fraudster or a seller could sell a sub-standard product or nothing at all in the e-commerce environment. According to Tan & Theon (2001), Brick-and-mortar commerce was the only one type of commerce in the marketplace in which buyers could see, touch and test product at the point of sale before ecommerce was established.

So, as suggested by Tan & Theon (2001), it is difficult to increase the trust of online users in ecommerce as compared to brick-and-mortar commerce because the buyer cannot see the seller and there could be impersonation, either known or unknown. To overcome these setbacks, this work present an approach to evaluate the level of trust between the merchant and the customers based on fuzzy logic. The focus of this work is to design a trust model for that can be used for the assessment of trust performance in e-commerce. The trust model is classified as Public Trust (customer satisfaction), Private Trust (customer data privacy, security) and Hybrid Trust (public trust, private trust, network infrastructure, cloud infrastructure and database management system).

1.2 Objective

The main objective of this study is to present an approach to evaluate the level of trust between the merchant and the customers based on fuzzy logic. Also, to design a trust model for e-commerce which it is classified as Public Trust, Private Trust and Hybrid Trust.

2. METHODOLOGY

2.1 The Proposed Ecommerce Trust Model

The proposed trust model uses feedback system from e-commerce customers based on their shopping experience through ratings on the scale of 1-5 based on the trust parameters displayed, once this feedback is being submitted, the system extracts the ratings and measure the level of trust using the mathematical equations been designed. Then the degree of trust derived from the mathematical computations will serve as the fuzzy inputs for the Sugeno inference engine which then evaluate the level of trust producing the final ecommerce trust such a way that e-commerce practitioners can understand the output of the trust assessment thereby using it for decision making with respect to customer satisfaction.

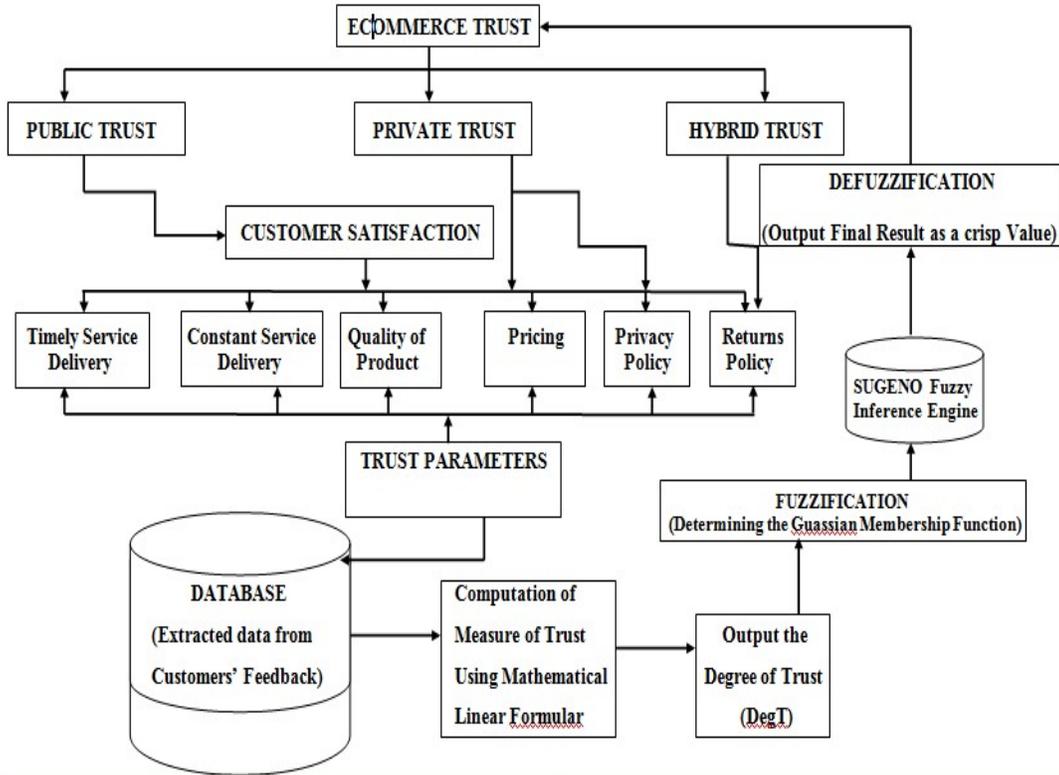


Figure 1: Architecture of the Proposed Ecommerce Trust Model (source: researchers, (2020))

3. TRUST MODEL EVALUATION

This study used five trust parameters in order to evaluate the level of the trust between customers and merchant, in achieving this objective, the trust parameters was divided in accordance with the level of priority. Constant service delivery and timely service delivery are probabilistic in nature while the other parameters are deterministic. The five parameters used in the trust evaluation are Constant Service Delivery (CSD), Timely Service Delivery (TSD), Quality of Product (QP), Pricing (P), and Returns/Privacy Policy which will be broken down into two entities in the trust computation namely Privacy Policy (PP) and Returns Policy (RP). The weight1 (W_1), weight2 (W_2) and weight3 (W_3) was assigned to each parameter according to the level of importance. The W_1 , W_2 and W_3 indicate the level of importance or weight assigned to each trust parameters according to their level of priority in the customer's perspective. Based on the level of importance, the privacy policy (PP), constant service delivery (CSD) and quality of product (QP) falls under the weight1 (W_1) while timely service delivery (TSD) and return policy (RP) falls under the weight2 (W_2) and the pricing (P) falls under weight3 (W_3) since the price is always fixed and the customers are not allowed to modify or influence the price of the goods but the price must be friendly. Values are assigned to the weights of each parameter while the value for each trust parameters itself is gotten from the ratings given by the customers from the online survey which ranges between the value of 1 to 5.

Trust (T) is given as:

$W_1(PP + CSD + QP) + W_2(TS + RP) + W_3(P)$ equation 1, which is further broken down as:

$$(W_1PP + W_1CSD + W_1QP) + (W_2TS + W_2RP) + (W_3P)$$

Therefore, Trust (T) = $(W_1PP + W_1CS + W_1QP) + (W_2TS + W_2RP) + (W_3P)$ equation2

Where,

$W_1 = 3$ that is, the weight value assigned to it (Weight 1)

$W_2 = 2$ that is, the weight value assigned to it (Weight 2)

$W_3 = 1$ that is, the weight value assigned to it (Weight 3)

PP = Privacy policy

CS = Constant Service Delivery

Qp = Quality of product

TS = Timely Service Delivery

RP = Returns policy

P = Pricing

Note: PP, CS, Qp, TS, RP and P are ratings from the customers that is, the value inputted in the online survey for each parameters.

While Trust percentage is given as

$$\%Trust = (Trust / 70) * 100\% \text{equation3 in a best case scenario}$$

Where in the best case scenario, if a customer give the value of 5 to all the trust parameters which is the highest value to be given:

For example, from the equations, if the value of 5 is been assigned to all trust parameter from the ratings, then:

$$W_1(PP + CSD + QP) + W_2(TS + RP) + W_3(P) \text{equation 1}$$

$$Trust (T) = (W_1PP + W_1CS + W_1QP) + (W_2TS + W_2RP) + (W_3P) \text{ equation 2}$$

That is, $W_1 = 3$, $W_2 = 2$, $W_3 = 1$, PP, CS, Qp, TS, RP and P = 5 in a best case scenario

$$3(5 + 5 + 5) + 2(5 + 5) + 1(5) \text{ equation 1}$$

$$(3*5 + 3*5 + 3*5) + (2*5 + 2*5) + (1*5) \text{equation 2}$$

$$(15 + 15 + 15) + (10 + 10) + (5)$$

$$Trust (T) = 45 + 20 + 5 = 70$$

$$\%Trust = (Trust / 70) * 100\% \text{equation 3}$$

$$\%Trust (T) = (70 / 70) * 100\%$$

$$\%Trust (T) = 100\%$$



Where in the worst case scenario, if a customer give the value of 1 to all the trust parameters which is the highest value to be given:

For example, from the equations, if the value of 1 is been assigned to all trust parameter from the ratings, then:

$$W_1(PP + CS + QP) + W_2(TS + RP) + W_3(P) \dots\dots\text{equation 1}$$

$$\text{Trust (T)} = (W_1PP + W_1CS + W_1QP) + (W_2TS + W_2RP) + (W_3P) \dots\dots \text{equation2}$$

That is, $W_1 = 3, W_2 = 2, W_3 = 1, PP, CS, Qp, TS, RP$ and $P = 1$ in a best case scenario

$$3(1 + 1 + 1) + 2(1 + 1) + 1(1) \dots\dots\dots \text{equation1}$$

$$(3*1 + 3*1 + 3*1) + (2*1 + 2*1) + (1*1) \dots\dots \text{equation2}$$

$$(3 + 3 + 3) + (2 + 2) + (1)$$

$$\text{Trust (T)} = 9 + 4 + 1 = 14$$

$$\% \text{Trust} = (\text{Trust} / 70) * 100\% \dots\dots\dots\text{equation3}$$

$$\% \text{Trust (T)} = (14 / 70) * 100\%$$

$$\% \text{Trust (T)} = 20\%$$

The above computation is for an existing customer but for a new customer who is just visiting the ecommerce site for the first time or has not been frequently transacting on the site and cannot give an accurate rating for the Constant Service delivery, so therefore:

Trust (T) is given as:

$$W_1(PP + QP) + W_2(TS + RP) + W_3(P) \dots\dots\text{equation 4, which is further broken down as:}$$

$$(W_1PP + W_1QP) + (W_2TS + W_2RP) + (W_3P)$$

$$\text{Therefore, Trust (T)} = (W_1PP + W_1QP) + (W_2TS + W_2RP) + (W_3P) \dots\dots\dots \text{equation5}$$

$$\% \text{Trust} = (\text{Trust} / 55) * 100 \dots\dots\text{equation6}$$

4. FUZZY INFERENCE SYSTEM

Fuzzy logic theory is used so as to extend the mathematics ontology in a certain method with fuzziness for intelligent decision making. Sugeno fuzzy inference is one of the popular control approaches which use the fuzzy theory and takes fuzzy set of inputs to produce a final output value as crisp value, the fuzzy sets of input is used to characterize the fuzzy value for each trust parameters in order to produce the five fuzzy sets of output. In using the Sugeno fuzzy technique, neural networks are used to reduce the number of fuzzy rules which provides a more convenient method of evaluating the level of trust between the customers and the merchant since the fuzzy sets for the five inputs always take into consideration all possible combinations of inputs. Four fuzzy sets will be used for the input factors and five fuzzy sets will be used for the output parameters. The four fuzzy sets which are low (L), medium (M), high (H) and very high (VH) will be used to characterize the fuzzy value for each input which are constant service delivery (CSD), timely service delivery (TSD), quality of product (QP), pricing (P) and return/privacy policy (RPP).

While the fuzzy sets that represent the output parameters are: very poor (VP), poor (P), good (G), very good (VG) and Satisfactory (S) but the use of four fuzzy sets for five inputs will take into consideration all possible combinations of inputs. The fuzzy set for all input factors and output parameters was defined, a Gaussian membership function was applied to determine the degree of input to the fuzzy set which will determine how each of the values in the input range belong to the input space of the membership value and the range is between 0 and 1. The table below shows the sample of the fuzzy rules for evaluating the level of trust and the assigned values of the outputs.

Table1: Fuzzy rules for evaluating the level of trust and the assigned values of the outputs

IF CSD	AND TSD	AND QP	AND P	AND RP	AND PP	THEN Ecommerce Trust
L	L	L	L	L	L	VP
M	L	L	M	M	L	VP
M	L	M	L	M	H	G
L	M	M	L	H	L	P
M	L	H	M	L	M	G
H	M	H	M	L	VH	VG
VH	H	VH	H	M	VH	S

Ssource: Researcher, (2020))

4.1 Fuzzy Inference Rules for Ecommerce Trust Evaluation

Fuzzy inference is the process of formulating the mapping from a given input to an output using fuzzy logic, this mapping then provides a basis from which decisions can be made, or patterns discerned (Kusumadewi *et al.*, 2013). Based on the neural networks since the work will be using the Sugeno fuzzy inference, the most important rules of the inference system were selected. In order to give the model accuracy and better performance, the online survey will be used to determine the means of selecting fuzzy rules.

Sugeno fuzzy inference method was used in the model and it takes the fuzzy set of inputs to produce a final output value as a crisp value, it uses the if-then rule which can be defined as: -

$R(j): \text{IF } a_i \in X_{1j} \text{ and } \dots \text{and } b_n \in Y_{nj} \text{ THEN } y \in C_j. \text{ Where, } j = 1, 2, \dots, N$

Where N is the number of rules

According to the definition stated above, below are 5 fuzzy rules in the proposed e-commerce trust model.

Rule 1:- If Constant Service Delivery (CSD) is low and Timely Service Delivery (TSD) is low, and Pricing (P) is low and Quality of product (QP) is low and Returns Policy (RP) is low and Privacy Policy (P) is low then Ecommerce Trust is Very Poor.

Rule 2:- If Constant Service Delivery (CSD) is medium and Timely Service Delivery (TSD) is low, and Pricing (P) is low and Quality of product (QP) is medium and Returns Policy (RP) is medium and Privacy Policy (P) is low then Ecommerce Trust is Very Poor.

Rule 3:- If Constant Service Delivery (CSD) is medium and Timely Service Delivery (TSD) is low, and Pricing (P) is medium and Quality of product (QP) is low and Returns Policy (RP) is medium and Privacy Policy (P) is high then Ecommerce Trust is Good.

Rule 4:- If Constant Service Delivery (CSD) is low and Timely Service Delivery (TSD) is medium, and Pricing (P) is medium and Quality of product (QP) is low and Returns Policy (RP) is high and Privacy Policy (P) is low then Ecommerce Trust is Poor.

Rule 5:- If Constant Service Delivery (CSD) is high and Timely Service Delivery (TSD) is medium, and Pricing (P) is high and Quality of product (QP) is medium and Returns Policy (RP) is low Privacy Policy (P) is very high then Ecommerce Trust is Very Good.

Rule 6:- If Constant Service Delivery (CSD) is very high and Timely Service Delivery (TSD) is high, and Pricing (P) is very high and Quality of product (QP) is high and Returns Policy (RP) is medium Privacy Policy (P) is very high then Ecommerce Trust is Satisfactory.

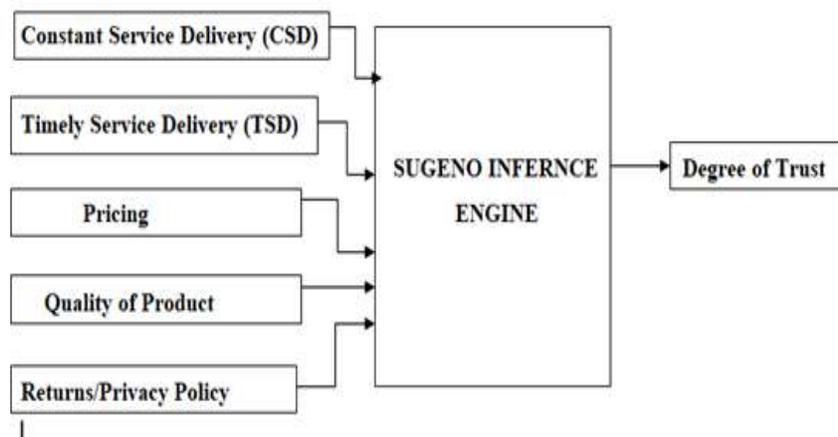


Figure 2: Architecture of Sugeno Fuzzy Inference
(Source: Researchers Fieldwork Model, 2020))

5. DISCUSSION OF FINDINGS

The ecommerce trust model proposed in this section is composed of seven modules where six modules were used to quantify the trust measure of the six trust parameters or matrices identified in our trust model (Constant Service Delivery (CSD), Timely Service Delivery (TSD), Quality of product (QP), Pricing (P), Returns Policy (RP) and Privacy Policy (PP)) while the seventh module is the final decision maker (e-commerceTrust) to quantify the trust factor. The use of fuzzy reasoning is justified as an adequate approach to deal with evaluating trust in e-commerce as it has the ability to quantify imprecise data and quantify uncertainties in measuring the trust factor of the vendors and to deal with variable dependencies in the system by decoupling them using human expertise in the form of linguistics rules. The results of the analysis suggest that measuring trust in e-commerce is a complex approach that can be solved for both quantitative and qualitative attributes.

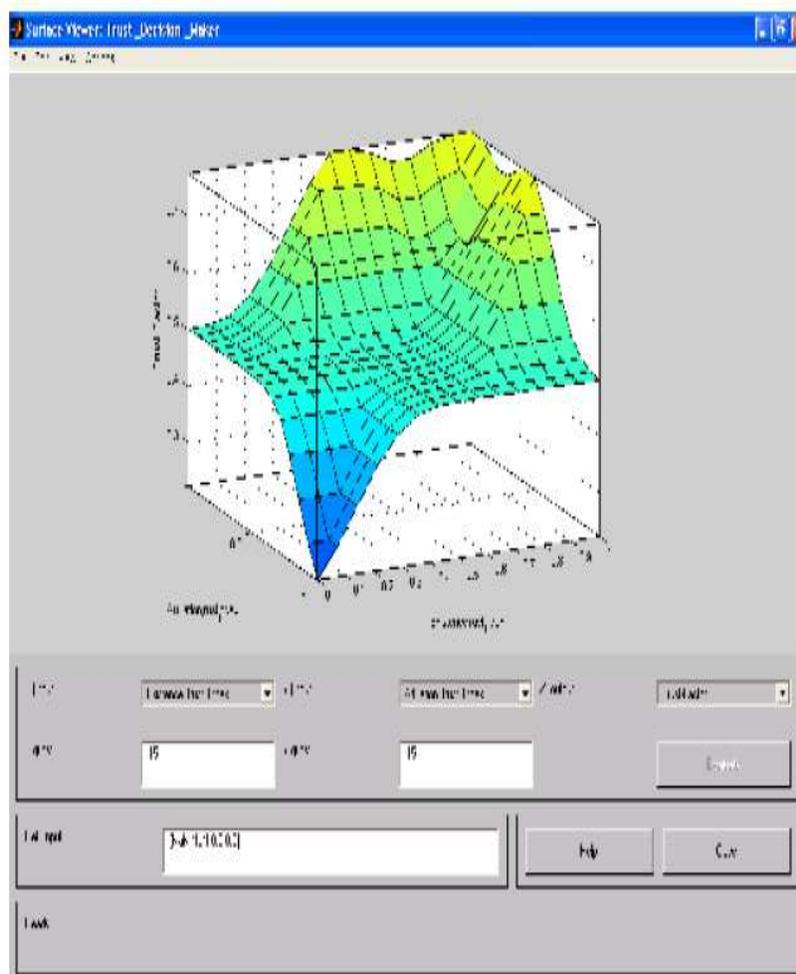


Figure 4: E-commerce trust output

Source: Researcher, (2020))

6. CONCLUDING REMARKS

Finally, this research presents a detailed framework, conceptual design and prototype of a fuzzy logic approach which can aid e-commerce practitioners in deciding the appropriate trust models to use for the evaluation of trust performance of their customers. The design is based on the ideas and concepts of fuzzy logic theory and fuzzy expert systems. The decision to trust or not to trust in e-commerce as a shopping medium is up to consumers' evaluation which can be based on many factors such as price, convenience, selection of choice and the information available on the merchant's website like those defined in the proposed model. It is widely accepted that if the economic gain is greater than the risk involved then the transaction is reasonably viable.

7. CONTRIBUTIONS TO KNOWLEDGE

In light of the study, and in order to understand the influence of trust on the assessment of e-commerce the following recommendations are suggested.

- i. The trust assessment model presented in this work would be of great help to e-commerce trust assessment evaluation developers in make efficient, reliable and valid decisions.
- ii. The model presented a well-structured, scientific and critical approach at solving complex e-commerce trust assessment problems.
- iii. In designing a trust assessment, the study presents a mathematical, psychological and logical way for making efficient decision in uncertain and ambiguous situation.

REFERENCES

1. Chonghua W., Che X. S., Feng R., & Liang, X.. (2015) A lightweight trust management based on Bayesian and Entropy for wireless sensor networks. *Secur. Commun. Netw.*, 8, 168 175.
2. Elena Starikova (2013, September). BirchBox, the future Business Model of E-Commerce. A Thesis Presented to the Faculty of European University In Partial Fulfillment of The Requirements for the Degree: Bachelor of Business Administration September 2013. Retrieved from <https://www.slideshare.net/Yelenastarikova/birch-boxthe-future-business-model-of-ec>
3. Hoffman, D. L., Novak T. P., & Peralta M. (1999, April). Building Consumer Trust Online," in *Communications of the ACM*, vol. 43, 1999, pp. 80-85. Retrieved from: <https://mcacm.acm.org/magazines/1999/4/...building-consumer-trustonline/fulltext>
4. Kusumadewi A. (2013) Application Of Fuzzy Inference System By Sugeno Method On Estimating Of Salt Production Tony Yulianto¹, Department of Mathematics, Faculty of Science, University of Islam Madura (UIM) Bettet No.04, Pamekasan, Madura 60111 Indonesia. Retrieved from <https://aip.scitation.org/doi/pdf/10.1063/1.4994442>
5. Liro P. (2015). Dynamical Trust and Reputation Computation Model for B2C E-Commerce ISSN 1999-5903 www.mdpi.com/journal/futureinternet, Future Internet 2015, 7, 405-428; doi:10.3390/fi7040405.
6. Mamdani E.H, & Assilian S., (1975, January). An experiment in linguistic synthesis with a fuzzy logic controller. *International Journal of Man-Machine Studies* Volume 7, Issue 1, January 1975, Pages 1-13. Retrieved from [https://doi.org/10.1016/S0020-7373\(75\)80002-2](https://doi.org/10.1016/S0020-7373(75)80002-2)
7. Mayer, R., Davis, J., & Schoorman, F. (1995). An Integrative Model of Organizational Trust. *The Academy of Management Review*, 20(3), 709 734. Retrieved from <http://www.jstor.org/stable/258792>
8. Mehrnoush Divsalar, Mohammad Abdollahi Azgomi, Mehrdad Ashtiani (2015). A Computational Trust Model for E-Commerce Systems: Concepts, Definitions and Evaluation Method. *International Journal of Information & Communication Technology Research (IJICTR)*. Volume 7- Number 2 – Spring 2015.
9. Paolo, G. M. & Johnson, S. C. (2009). A Comprehensive Model of Customer Trust in Two Retail Stores. Cornell University School of Hotel Administration. The Scholarly Commons Articles and Chapters School of Hotel Administration Collection. Retrieved from <https://scholarship.sha.cornell.edu/articles/705/>

10. Lewicki, R.J. and Bunker, B.B. (1996) Developing and Maintaining Trust in Work Relationships. In: Kramer, R.M. and Tyler, T.R., Eds., *Trust in Organizations: Frontiers in Theory and Research*, Sage Publications, Thousand Oaks, 114-139. Retrieved from <http://dx.doi.org/10.4135/9781452243610.n7>
11. Siddhi, P. & Mohini, S. (2014, May 1). Trust Models in the E-Commerce Environment, School of Business Information Technology, RMIT University GPO Box 2476V, Melbourne, Victoria 3001, Australia, The Fourth International Conference on Electronic Business (ICEB2004) / Beijing 901. Retrieved from https://www.researchgate.net/.../221365909_Trust_models_in_the_ecommerce_enviro
12. Tan, Y. & Theon, W. (2014, December 24). Toward a Generic Model of Trust for Electronic Commerce. *International Journal of Electronic Commerce*, 5(2): 61-74. Retrieved from <https://www.tandfonline.com/doi/abs/10.1080/10864415.2000.11044201>
13. Tricia Hussung (2016, July 28). From Storefronts to Search Engines: A History of E-Commerce. Concordia St. Paul Blog & News Updates. Retrieved from <https://online.csp.edu/blog/business/history-of-ecommerce>
14. Will K. (2018, January 29) Commerce. Investopedia, Investing Financial Analysis. Retrieved from <https://www.investopedia.com › Investing › Financial Analysis>