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Fuzzy Multi Attribute Decision Making–Simple Additive Weighting (MADM-SAW) for Information Retrieval (IR) in E-Commerce Recommendation

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ABSTRACT

E-commerce has been rapidly in demand because of the sufficient easy features provided. However this easy access raises some new dilemmas for the potential buyers determining which e-commerce to choose, as well as understanding the most trusted and recommended e-commerce existed. Five criteria can be used to be help in determining the good quality e-commerce recommendations, include the value of feedback and reviews, the reputation of the online shop, the price of the product, the number of products sold from the online shop, and the content of the product. This research produces a fuzzy multi attribute decision making-simple additive weighting (MADM-SAW) model for information retrieval (IR) on ecommerce recommendations, where fuzzy calculation results are the alternative end value in e-commerce recommendations. The research method used in this research is the Research and Development (R&D) method that is only done on trial product or limited trial only. So then, based on the experimental results, it is found that content not only matches the search query, but there is also a comparative information about the satisfactory value of the product feedback and reviews, the reputation of the online shop, the reliable price of the product, and the number of products sold from the online store.

Keywords: *E-Commerce, Fuzzy MADM-SAW, Information Retrieval, Recommendation*.

1. INTRODUCTION

The phenomenon of trading through electronic media or e-commerce is parts of the dissemination, purchase, sale, marketing of products and services through electronic systems such as internet, television, commercial web, or other computer networks. Since then, e-commerce, that continues to grow and develop around the world, is believed to have become an important and significant part of global economic growth [1]. The development of e-commerce in Indonesia itself is very rapid and this cannot be separated from internet users who reached 88.1 million people, plus social media users as much as 79 million with a population of 259.1 million inhabitants. In 2014, Euromonitor reported that Indonesia's online selling has reached the amount of US $ 1.1 billion in total, which is the highest of the amount sold by Thailand and Singapore in which makes Indonesia become the largest e-commerce trading market in South-East Asia [2].

E-commerce is increasingly in demand by the society because of the sufficient convenience given by its feature, such as the process of finding the products to be purchased. Consumers can find the desired goods or products faster. Then, the consumers can compare prices in one place with another place easily, without physically going to the existing supermarkets. The buyers can arrange their electronic payments more practical and less complicated, either by bank transfer or credit card.

However, this accessible feature has caused some new dilemmas for the potential constumers in finding and buying their preferable things in the online market. The difficulty to decide which e-commerce is credible and to find which e-commerce is trusted has become the issues and the dilemmas for the potential consumers.

As we know that the needs of information and communication these days has become very essential for the society while the technology is also rapidly developing. These matters has led to many kinds of innovations to improve the efficiency and the efficacy of getting those varieties of imformations. In the discussion of the case of e-commerce, the category of infomations collected is needed. The category of informations that are profound and focused on searching the supplies in the e-commerce that has many choices. In connection to that, the promptness, the clarity and the accuracy of the information has become one of the important things to

begin with in getting the precise informations. Although these days the search engine has been playing the essential role in seeking an information, it is still found that the result was not sufficient to the enxtent that it could be more precise and according to what is expected from the very first place. For instance, the biggest issues found was the amount of pages resulted from the searching was way too many and oftenly they were irrelevant with the needs of the costumers. Meanwhile, in using the searching features in each different e-commerces cannot easily help the customers to compare the one searching results to another. The online shops could not also provide some informations regarding to the certain customers' preferences to see the rank of recommendation as default, in which the online shops have to provide platforms to set the relevant rank of recommendation according to customers' standard which are somewhat undefined. The algorithm raking style that was used beforehand only could rank the recommendation based on 1 attribute or criteria such as the lowest price to the highest price, which however has led to the innacuracy rank found in its feature. One of the researches entitled Using PageRank for Non-Personalized Default Ranking in DynamicMarkets stated that the more attributes or criterias used as determiners to rank the supplies in the online shops, the closest the results will appear as in it is approaching the similirities of the consumer's standard and preferences. [3].

There are 8 important criterias in e-commerce web which has been elaborated in that particular related research. Those essential components are the intensity, transaction, products, costumers' satisfaction, services, contents, design, aesthetics and the security [4][5]. This research will involve 5 (five) of those attributes/criterias to decide the e-commerce recommendation, in which it is talking about the price of the products, the amount of supplies sold by particular shops with the intensity of the transaction, previous buyers' rating towards the product (feebacks/review of the products) which related to the costumers'satisfaction, the reputation of the online shop which related to the quality of services given by the particular shops, and the result made by Information Retrieval weighting which related to the contents. Therefore, this research is looking for a proper method that could accomodate these attributes/criterias which later will be used to calculate the end alternative value to rank the e-commerce recommedation for the costumers.

The fuzzy logic is one of the methods to identify the expansion of multivalue logic. This model provides the most comprehensible framework for the new users of information retrieval (IR) system.The documents obtained from the query are evaluated by Fuzzy Inference System (FIS) rules that have precise semantics accumulation [6]. Fuzzy logic has a very good performance to solve problems that contain uncertainty in decision making, in the use of fuzzy logic membership function is used to determine the recommendation of prospective goods to be purchased and has been calculated on each predefined criterion variables.

Furthermore, based on the above discussion, it can be taken into account that the informational retrieval process in e-commerce is a form of research that involve several variables and essential criterias to recommend some supplies the customers are about to purchase. Thus, the logic used of fuzzy multi attribute decision making – simple additive weighting is a precise and suitable method for the research since it has the ability to accomodate more than 1 variable in its calculation process (multi-attribute).

This research propose a fuzzy multi attrbute decision making-simple additive weighting (MADM-SAW) model, as in information retrieval (IR) in recommending an e-commerce in which the fuzzy calculation includes some conditions and criterias to provide more conveniences for the potentials buyers in deciding their preferable e-commerce.

2. LITERATURE STUDY

Information retrieval can be retrieved as a research that focused on: 1) the process of finding relevant documents towards the query; 2) the process of identifying a huge set of documents efficiently [7]. Ngomo and Witschel in a research entitled A Framework for Adaptive Information Retrieval proposed a framework where in the process of findings there should be 3 important elements to begin with, such as: 1) defining the data resources; 2) to transform the content of a document to gain a logical point of view; 3) to develop a text index from the logical point of view [8]. Information Retrieval itself has been used in many aspects of life, even more, this method has been found to be implemented in many IR cases. For some instances, it has been implemented to IR semantic-based [9][10][11], IR intentions-based [12], IR learning to rank basis [13][14][15], and many more.

As it is stated before that the fuzzy logic is one of the methods to identify the expansion of multivalue logic. This logic has been widely used in many aspects of life. For instances, it is used for the active suspension on vehicles, [16], examination scheduling system [17], forecasting/short-term weather forecasting [18], and many more instances.

The use of fuzzy logic has been used to rank in e-commerce issue according to a research conducted by Ranking Criteria based on Fuzzy ANP for Assessing E-commerce Web Sites where it gave some essential rank according to the important criteria in e-commerce [5], as well as it is resulted in an online community to identify

the rank of reviewers according to their written feedback in a discussion [19]. Meanwhile the method used to rank the information retrieval itself has been conducted towards weighting and ranking several documents using Generalized Ensemble Model [20]. However, the ranking process in IR by using the fuzzy logic was rarely conducted, even to the extent that none was ever governed.

Fuzzy logic in the information retrieval was once used to build and integrate different relevance profiles [21], to increase the number of relevance classes in output and improve the performance of information retrieval systems [22].

Eventually, this research propose the use of a ranking method on information retrieval in the e-commerce to identify the recommended online shops by using the fuzzy multi attribute decision making – simple additive weighting, in which the score calculation resulted from the e-commerce recommendation rely on some criteria that has been set beforehand. Thus, it is expected to see the works of this method will make it easier for buyers to decide which e-commerce they should choose in doing an online shopping without a burden to compare from one page to another of an e-commerce.

3. PROPOSED MODEL

This research is using the Research and Development (R&D) method in finding its data. This method is being used in a purpose to find a result of certain products, and to examine the efficacy of the product itself [23].

The proposed model system has been divided into 4 main parts such as 1) user query; 2) searching process; 3) information retrieval with MADM-SAW Fuzzy Logic; and 4) goods recommendation

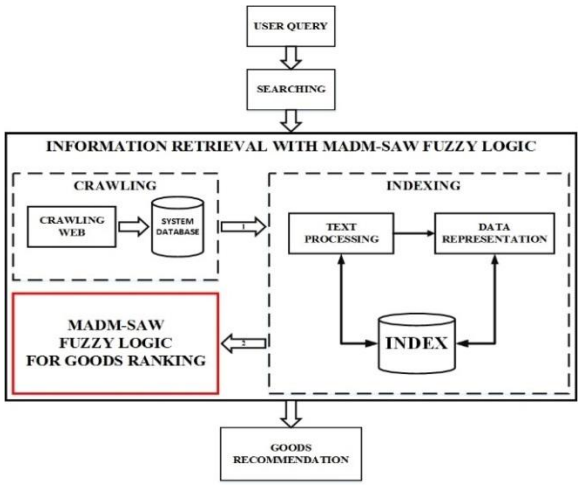

Fig. 1. Fuzzy Multi Attribute Decision Making-Simple Additive Weighting towards Information Retrieval towards E-Commerce Recommendation

1.1 User Query

In this stage, the potential buyers should enter some key words related to the products needed in a searching box which later on will be processed to find the potential recommendation about the online products those buyers are going to purchase.

3.2 Searching

In this stage, the searching process is being conducted in which it is related to the proceeding process in getting the information.

3.3 Information Retrieval with FMADM-SAW

In this stage, there are 2 (two) main processes that are being conducted which are information retrieval towards the previous data which was collected from web crawling process and the calculation done by fuzzy MADM-SAW. It gives a result where the products recommendation are based on the significant rank and filtered by some certain criteria. After conducting some attempts to compare some e-commerce web based on the essential parameter adapted from the related research [24], it was taken into account that there would be 2 (two) e-commerce webs that will become the objects of the research which are tokopedia and bukalapak. The decision to pick these 2 (two) webs are because they have fulfilled the precise conditions of a well-established e-commerce webs.

To identify the recommended online shop in this research, it is set to be led by 5 main criteria as follows:

1. The feedback/review of the product (C1): related to the customer's satisfaction towards the chosen shop or products.
2. The reputation of the online shop (C2): how the shop performs its work through its quality of services
3. The price of potential products (C3): related to the information about where the buyer often compare one online shop price to another.
4. The amount of products sold by the shop (C4): related to the transaction flow intensity done in that particular shop in which triggers the potential buyers to purchase products on that particular online shop.
5. The result of information retrieval weighting process (C5): related to the contents' relevance where the weighting (relevance score) is done through the previous information retrieval process

Fig. 2. shows the hierarchical structure of the problem that is built based on permanent considerations.

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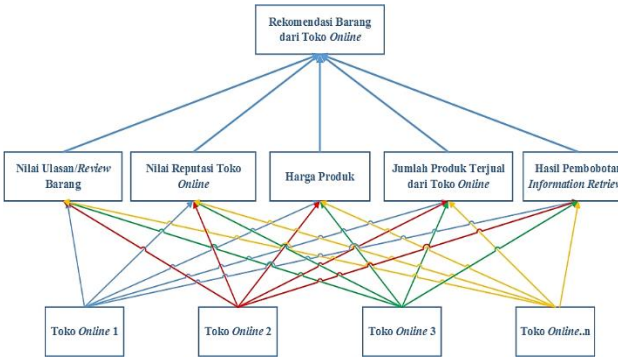

Fig. 2. Hierarchical Structure of the Problem

A previous related research entitled Using PageRank for Non-Personalized Default Rankings in Dynamic Markets stated that every attribute or criteria in an e-commerce are all essentials to one another in which the conditions shown that there is no dominant attribute to begin with. The result of the experiment stated that the more average the weighting of the preference (*W*) of each criteria, then the variance / diversity and standard deviation of the deviation on the simulation will be smaller [3].

Table 1: The combination of weighting [3]

	Attribute Weights	Variance
1	(1,0,0,0,0)	0.20
2	(0.8,0.2,0,0,0)	0.12
3	(0.6,0.4,0,0,0)	0.08
4	(0.6,0.2,0.2,0,0)	0.06
5	(0.4,0.4,.0.2,0,0)	0.04
6	(0.4,0.2,0.2,0.2,0)	0.02
7	(0.2,0.2,0.2,0.2,0.2)	0.00

From that point, the preference weighting in this research will be counted into an average base of 0.2 (*Wi* = 0.2 $\alpha_i \in A$) from five of the determined criteria.

Table 2: Value of Weighted Preference in Each Criteria

	Kriteria	Bobot
C1	Feedback/*Review* of the product	0.20
C2	Reputation of the shop	0.20
C3	Price of the product	0.20
C4	Amount of product sold by the shop	0.20
C5	*Information Retrieval* weighting process	0.20
	TOTAL	1.00

Hence, from all those 5 (five) criteria above, each of them has different scales of values. So, the research decided to assimilate these 5 different kinds of criteria. C1 and C2 will be classified into a certain determined values by tokopedia and bukalapak. C3, C4 and C5 will be using Min-Max Normalization [25].

$$A' = \left(\frac{A - \min value\ of\ A}{\max value\ of\ A - \min value\ of\ A} \right) \quad (1)$$

The equation (1) is a form of equation in min-max normalization. *A'* refers to the results collected from 1 selected data which has been normalized according to the range of min-value to max-value calculation. *A* is referring to the range of the authentic data, while min value of *A* is referring to the lowest value of A, in which max value of *A* definitely refer to the highest value of *A*. The next action will be one after all the comparison of numbers is gained through the normalized factor table input.

Table 3: Table of Normalization Factor

E-Commerce Shop	Criteria				
	C1	**C2**	**C3**	**C4**	**C5**
Shop 1 (A1)	*A1C1*	*A1C2*	*A1C3*	*A1C4*	*A1C5*
Shop 2 (A2)	*A2C1*	*A2C2*	*A2C3*	*A2C4*	*A2C5*
Shop 3 (A3)	*A3C1*	*A3C2*	*A3C3*	*A3C4*	*A3C5*
Shop 4 (A4)	*A4C1*	*A4C2*	*A4C3*	*A4C4*	*A4C5*
Shop..n (A..n)	*A..nC1*	*A..nC2*	*A..nC3*	*A..nC4*	*A..nC5*

Moreover, after the result has been showed through the table, the data will be multiplied from each column in the table using the weight of the criteria that has been determined in the very first place.

$$V_i = \sum_{j=1}^{n} w_j r_{ij} \quad (2)$$

Vi has referred to the latest alternative values, *Wi* indicates the determined weight, *rij* shows the normalization of the matrix. The largest value of *Vi* indicates that *Ai* alternative is preferable [26].

3.4 Goods Recommendation

In this last section, the user can receive the result of the online products and the online shop recommendation. They could look for the recommendation based on the rank that was gained from the previous process.

4. Results

The data was collected from a group of students in UKSW, while for the sample taking itself was using the quasi experiment with the design of non-equivalent pretest-posttest control group. The samples were spread non-randomly throughout 30 students in UKSW. The research was divided into two sub-groups in which the first experiment was focused on 15 students and the other 15 students are included into a control group. The control group are not included to the authentic

experiment of the research in which they were being neutral towards the research. While the experiment-focused group is a group in which the research is conducted by using the free variable through the method of fuzzy MADM-SAW towards IR in e-commerce recommendation.

To test the effectivity of the implementation of the developed model, it is necessary to formulate the effective criteria of models in which achievements are significantly practical and statistically significant as described below. 1) Practically significant: The development of fuzzy multi attribute decision making - simple additive weighting (MADM-SAW) model for information retrieval (IR) on ecommerce recommendations should have the power and impact to the student's tendency to choose e-commerce when shopping online. 2) Significant Statistics: (a) the mean and pre-post N-gain values produced by the experimental group must be higher than the value of the control group; (b) a recapitulation of increasing in the results of the test should show that the pre-post value of the experiment is greater than the pre-post control. The preparation of the questionnaire will use the Likert Scale [22].

In regarding to that, the examples of the results of the web crawling process on e-commerce web such as tokopedia and bukalapak have been taken into account and stored in the database system as explained in Fig. 3. Output is in the form of products identity, name of the item, description of the products and links/online shop, url of the products are loaded.

id_barang	nama_barang	deskripsi	url_barang
1	SEPATU NIKE SPORT CASUAL AIR MAX ZERO	NIKE AIR MAX ZERO,MODE VIETNAM,100% IMPORT,UKUR ...	https://www.tok /sepatukujangb /promo-s...
2	PROMO SEPATU KETS CASUAL SPORT PRIA	MODE VIETNAM,100% IMPORT,UKUR	https://www.tok /sepatukujangb /promo-s

Fig. 3. Name of the product, Description and saved links in the database from Web Crawling process

The simulation system limits the scope of the products searching like nike sport shoes products for men and women. Assuming the item we are looking for is nike **flyknite**. The query in this process is the **flyknite** input.

4.1 Information Retrieval Process

The information retrieval process was done by addressing it to the data of products collected as described in the Fig. 3 which shows the probability of the content according to the name of the product and the detail description of the product. It was found in the process that 1) Text Operation: word choices in the query, to the extent that the authentic document and transformed document or even the query has become the term index (index of words); 2) Indexing: developing the data based from the documents collected; 3) Query Formulation: to facilitate the weighting of the words index query; 4) Ranking: to search for relevant documents related to the query and to order the rank of the documents based on its reliability with the query.

Query/Input: flyknite
Output:

Table 4: Weighting Result of Information Retrieval

Product ID	Query	IR Score
5	flyknite	0.769757
41	flyknite	0.453424
18	flyknite	0.447651
19	flyknite	0.435273
10	flyknite	0.409962
114	flyknite	0.396135
42	flyknite	0.388276
13	flyknite	0.372431
12	flyknite	0.370189
150	flyknite	0.330739
11	flyknite	0.328949
54	flyknite	0.31877
104	flyknite	0.276662
145	flyknite	0.226996

4.2 Collecting the Value of the Variables based on the Criteria

The previous Information retrieval process has influenced the section where the variables and criteria are being identified. The process of the searching the data of the products with the query has been taken from the information given by the link/url of the online shops; in which the product choices is displayed through the Fig. 3. The identification of the values of the variable and the criteria has been conducted in real-time basis when the preferable product is being selected. The essential data includes the feedback and review of the product, the reputation/track record of the shop, price of the product, the amounts of products sold by the particular shop, and the result of IR weighting. All these data criteria was assembled through crawling web on the link/url of the online shops based on the products searched in that particular site.

4.3 The Process of Fuzzy MADM-SAW

Those 5 (five) variable values data and criteria identify that they still show signs of different scale of values. From that point, the normalization towards the variable

data and criteria must be executed to get the dimensionless among the data collected.
On the criteria of "feedbacks and product review" (C1), the process of normalization was done and described in Table 5 according to the permanent conditions set by tokopedia and bukalapak.

Table 5: Range and Normalization Score on Criteria 1 (C1) from Tokopedia and Bukalapak

C1 Range	Score
< 0.5	0.0
0.5 - 0.9	0.1
1.0 – 1.4	0.2
1.5 – 1.9	0.3
2.0 – 2.4	0.4
2.5 – 2.9	0.5
3.0 – 3.4	0.6
3.5 – 3.9	0.7
4.0 – 4.4	0.8
4.5 – 4.9	0.9
5.0	1.0

Referring to the criteria of "reputation of the shop" (C2), the normalization was done and described in the Table 6 (tokopedia) and Table 7 (bukalapak).

Table 6: Range and Normalization Value/Score based on Criteria 2 (C2) of Tokopedia

Badge	Point	Score
Belum Ada	-	0.00
Bronze 1	5-10 points	0.05
Bronze 2	11-35 points	0.10
Bronze 3	36-50 points	0.15
Bronze 4	51-100 points	0.20
Bronze 5	101-250 points	0.25
Silver 1	251-500 points	0.30
Silver 2	501-1000 points	0.35
Silver 3	1001-1500 points	0.40
Silver 4	1501-3000 points	0.45
Silver 5	3001-4500 points	0.50
Gold 1	4501-10000 points	0.55
Gold 2	10001-15000 points	0.60
Gold 3	15001-30000 points	0.65
Gold 4	30001-45000 points	0.70
Gold 5	45001-50000 points	0.75
Diamond 1	50001-100000 points	0.80
Diamond 2	100001-150000 points	0.85
Diamond 3	150001-200000 points	0.90
Diamond 4	200001-500000 points	0.95
Diamond 5	>500000 points	1.00

Table 7: Range and Normalization Value on Criteria 2 (C2) Adapted from Bukalapak

Badge	Point	Score
Belum Ada	1-10 points	0.00
Pedagang	11-100 points	0.125
Pedagang Besar	101-500 points	0.250
Calon Juragan	501-1000 points	0.375
Juragan	1001-5000 points	0.500
Good Seller	5001-10000 points	0.625
Recommended Seller	10001-50000 points	0.750
Trusted Seller	50001-100000 points	0.875
Top Seller	>100000 points	1.00

On the "price of the product" criteria (C3), the amount of the product sold by the shop (C4) and the previous result of IR weighting (C5), normalization is conducted by using the calculation of min-max normalization based on the equation (1).
After all the result of the normalization has been collected, the next step is to count the last alternative value by using the equation as follows (2).

Query/Input: flyknite
Output*:*

Table 8: Weighting Result based on Information Retrieval with Fuzzy MADM-SAW

Product ID	Query	IR Score with Fuzzy *MADM-SAW*
5	flyknite	0.848502
10	flyknite	0.71742
13	flyknite	0.678422
18	flyknite	0.559848
19	flyknite	0.559032
11	flyknite	0.516108
114	flyknite	0.463618
41	flyknite	0.44587
104	flyknite	0.439593
42	flyknite	0.421864
54	flyknite	0.399997
12	flyknite	0.362765
150	flyknite	0.27952
145	flyknite	0.263764

5. DISCUSSION

5.1 The Influence of Fuzzy MADM-SAW

The system's performance was calculated by considering the latest score that was gained from the information retrieval information retrieval process alongside with

fuzzy MADM-SAW. Table 9 indicates the result of the score comparison from the information retrieval process and information retrieval with fuzzy MADM-SAW.

Table 9: Score comparison between Information Retrieval with No Fuzzy MADM-SAW

Product ID	Query	Score	
		IR	IR with Fuzzy MADM-SAW
145	flyknite	0.226996	0.263764
104	flyknite	0.276662	0.439593
54	flyknite	0.31877	0.399997
11	flyknite	0.328949	0.516108
150	flyknite	0.330739	0.27952
12	flyknite	0.370189	0.362765
13	flyknite	0.372431	0.678422
42	flyknite	0.388276	0.421864
114	flyknite	0.396135	0.463618
10	flyknite	0.409962	0.71742
19	flyknite	0.435273	0.559032
18	flyknite	0.447651	0.559848
41	flyknite	0.453424	0.44587
5	flyknite	0.769757	0.848502

Hence, from the graph shown by Fig. 4, it can be observed that the result consideration shown by the information retrieval process displays the data whose content is in accordance with the search query. Whereas the consideration of the result of the retrieval process with fuzzy MADM-SAW produces data in which the content not only matches the search query, but there is also comparative information about the satisfactory value of the products reviews, the reputation of an online shop, the price of the product, and the number of products already sold from the online shop.

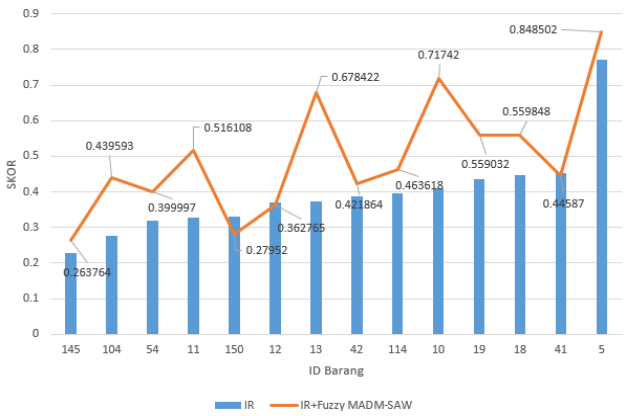

Fig. 4. Comparison of Latest Alternative Value of "IR" and "IR with Fuzzy MADM-SAW"

5.2 The Result of The Experiment

The examination done towards the Fuzzy MADM-SAW model towards Information Retrieval in e-commerce recommendation was conducted by taking samples from 15 students who was grouped into an experiment, where each participant should do 10 probations towards the experiment; they shop and from that the result can be seen from the deviation standard of varieties of recommendation appeared in the experiment. Thus, the smaller the value of deviation standard is found, the closer the standard of recommendation approach the consumer's unidentified preference. As much as 150 times of probations and comparisons has been done in order to get the result of the e-commerce recommendation with the IR process in which it only includes 1 attribute/criteria; content reliability. While the other attempt is an e-commerce recommendation using FMADM-SAW towards IR which more includes 5 (five) determine attributes/criteria.

The results showed that on recommendation with IR there were only 47 samples that chose the first recommendation and 103 other samples varied even further than expected, whereas in the FMADM-SAW recommendations in IR there were 139 samples who chose the first recommendation, 10 samples chose the second recommendation and 1 to select the third recommendation. This indicates that the more attributes/criteria used as consideration of the sorting of the goods recommendations, the better the results will be near the standards that consumers want. Table 10 shows the comparison of standard deviation values between e-commerce recommendations with IR and with FMADM-SAW in IR.

Table 10: Comparison of Standard Deviation Value with/without Fuzzy MADM-SAW

Attributes	Variance	Deviation Standard
1 (*IR*)	17.285	4.157
5 (*FMADM-SAW* in *IR*)	0.087	0.295

On the similar research that was conducted by using PageRank method, in determining the product recommendation with 1000 samples and variety of attributes 2 to 5 [3] had shown that the more attributes/criteria that are being used as the recommendation determiner, the smaller the value of deviation standard will become.

Table 11: Mean and standard deviation of the rank of the preferred product for PCRA using different attribute subsets [3]

Number of Attributes	2		3		4		5
	Mean	SD	Mean	SD	Mean	SD	*Baseline*
Energy-Saving Lamps	3.246	1.594	2.675	1.391	2.313	0.971	*2.029*
Hotel Rooms	3.723	1.646	3.512	1.662	3.498	1.262	*3.508*
Washing Machines	3.304	1.725	3.106	1.478	2.896	1.116	*2.710*

While the result of pretest-posttest sampling of both research groups which included a group of 15 students and a control group of 15 students, the result is described as follows:

- In the control group, the pretest average yield of 37.34% rose to 38.67% after the posttest. It is known that the MADM-SAW fuzzy model of application/simulation group for IR in e-commerce recommendations does not show significant changes to their understanding of online shopping that is easier and more reliable in terms of recommendations and trends in choosing a good online shop.
- In the experimental group, the average pretest result of 40.00% rose to 83.64% after the posttest. It is known that the experimental group of MADM-SAW fuzzy application/simulation system towards IR in e-commerce recommendations shows significant changes in a better direction for their understanding of online shopping that is easier and more reliable in terms of recommendations and trends in selecting the online products and shops.

After getting all the above results quantitatively, the developed model of MADM-SAW fuzzy for IRs on the e-commerce recommendations indicates that this model has provided an easy access and effectiveness for the potential buyers to do an online shopping without having to go through the long online store selection stage, especially in the comparison process.
Furthermore, interviews were conducted for each individual in the experimental group. From the interview, some results were found as follows:

- Application system/simulation allows users to choose items to be purchased while shopping online.
- Application system/simulation provides good recommendations in terms of quality of stores, goods and prices that is reliable towards the budget of the potential buyers.
- The tendency the application users/simulation system is to select the top 3 recommendations according to fuzzy calculations in the developed model.

From the result of the interview stated above, it was found qualitatively that the developed fuzzy MADM-SAW model which is being used towards IR in products recommendation has given significant positive impacts towards the users in daily basis. Furthermore, this model has shown that it could change the perspectives that there will be less barriers in choosing the preferable shop according to the customers' standard of quality, reliability and the credentials towards the online shop.

6. CONCLUSIONS

This research proposes the model of fuzzy MADM-SAW towards the use of IR in e-commerce recommendation which has discussed 4 core processes such as; 1) user query; 2) searching; 3) Information Retrieval with MADM-SAW Fuzzy Logic; 4) Goods Recommendation. Thus, in doing the calculation of Fuzzy MADM-SAW, there are 5 (five) main criteria that has become the essential determiners to identify the last alternative value in e-commerce recommendation. Those are the review/feedback, the reputation of the online shop, the price of the product, the amount of products sold by the online shop, and the value resulted by weighting information retrieval that was done previously. After taking 150 attempts of samples to examine the use FMADM-SAW towards IR in e-commerce recommendation, it indicates that the standard deviation value is as much as 0.295, in which it explains that the recommendation has nearly approached the standard preferred by the customers. Finally, it was found that quantitatively, it indicates that this model gives more efficacy and efficiency for an individual to do an online shopping without taking a long process of choosing his/her preferable shop and comparing it from one to another from the very first place. Hence qualitatively, it shows that this model has given some positive impacts towards the users of this system in their daily life as well as shifting the perspectives of the buyers that doing an online shopping is no longer difficult and troublesome. In this case, there will be less issues in choosing the preferable online shop.
This research is still using fuzzy multi attribute decision making-simple additive weighting method that requires a lot of input every time doing query and comparison operation. For future research development required research to store the results of each search based on user criteria for reuse in subsequent search by different users

but have similar criteria. This will ensure that historical or past information can be used as a next feedback feed.

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