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Online Shopping Decisions Enhancement with Fuzzy Expert System

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ABSTRACT

Purpose Nowadays, due to the rapid development of the Internet and the rapid growth of web pages, many electronic websites are using product recommendation systems to guide users to the products that they need. Such systems usually provide a list of suggested items that the user may prefer. These systems are provided as a support tool to help users obtain information that best meets their needs. These systems can actually improve user decisions, resulting in increased sales and mutual customer satisfaction. The purpose of the paper is to improve user decisions in online shopping using fuzzy expert system.

Methodology: The statistical population of this study consists of 30 experts in the field of e-commerce who were selected by combining two methods of deliberate sampling and snowball sampling. To analyze the status of improvement of users' decisions, a fuzzy expert system was created using input variables business reputation status, environmental factors status in e-commerce, online store features; product specifications; user/customer characteristics.

Findings: The final results showed that there is no significant difference between the results of the created expert system and the mean of expert opinions.

Originality/Value: In this paper, a conceptual Model to improve user decisions in online shopping using a fuzzy expert system is designed.

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1. Introduction

Recommender systems provide a way for personalized suggestions from existing information which can play an important role in systems such as e-commerce. Most of these systems work on a group refinement method, which, based on reviews by similar users or customers of the system, tries to predict a list of possible items of interest to the user and by suggesting this list to the user increases site transactions and overall productivity of the System. On the other hand, with the increase in the volume of information in such systems, there will be a significant decrease in efficiency, making it difficult for the system to be online [1]. Expert systems have been developed in order to solve the information overload problem on the internet and are nowadays important tools for e-commerce. In these kinds of systems by making appropriate offers for purchase lead to more amount sales and also leads to the customer's satisfaction from online shopping. An Expert system in an electronics store can play the role of a skilled salesperson and drive the shopping market [2].

Currently, there is intense competition between manufacturers and suppliers of products. On the other hand, customers are looking for the best quality and services at the lowest price, and e-commerce enables the manufacturer, supplier and customer to find each other easily on a larger scale regardless the geographical distances [3]. This means by the means of e-commerce that manufacturers of products or service providers can easily find customers for their products at minimal cost from anywhere in the world. Customers, on the other hand, can easily reach to their desired service in the shortest possible time according to their taste and budget [4, 5]. Online shopping in the field of e-commerce can be defined as "shopping by electronic technologies and tools". Online shopping succeeds when sellers can deliver more economic benefits to customers than the traditional way. To display products on beautiful websites with varied and attractive photos on online sale is not enough. According to the Communications Policy Center, 43 percent of Internet users make online purchases, and online shopping is recognized as the third most popular Internet activity after using email and web search [4]. Today, creative and active audiences are growing with relatively accessible media tools and programs whose culture has influenced global audiences and mass media [5, 6, 7]. There are various theories behind the motivation for participating in user-generated content from friendly motivations to social and materialistic motivations. Because of the high value of user-generated content, many sites offer incentives to encourage people. Based on the purchase history, view history and the item the user is viewing, they recommend the user to consider items for purchase. Expert technology from the time it was used by Amazon has been incorporated into many e-commerce and online systems, often based on collaborative refinement. A significant incentive to do this is to increase sales amount, customers may buy a product if they are offered, but they may not buy the product if they are not offered. Many companies such as Netperceptions and Strands have been developed in order to provide technologies for advisory service for retailers [8]. Expert systems are systems that help users in finding and choosing the items they need. It is natural that these systems will not be able to offer without sufficient and accurate information about users and their desired items (for example movies, Music, books, etc.). Therefore, one of their most important goals is to gather diverse information about users' preferences and items in the system.

Arora et al., have revealed that suggestions play a very important role in our daily lives. There are various ways to study these systems that usually use a matrix approach. They presented their proposed Expert systems based on trust. Since in all the work done in Expert systems until now with matrix approach have considered the relationship between variables linearly, in the proposed method using Gaussian core method considers nonlinear relationships to obtain better results [9]. Abbas et al., observed that today with the rapid development of the Internet and the rapid growth of web pages, many electronic websites are using product expert systems to guide users to the products they need. Experiments show that the expert system has higher accuracy and recall than comparable algorithms [10]. Esmaeili et al., showed that recent changes in internet surfers' behavior and the growing importance of communication information technologies Shows that more attention should be paid to e-surfing. They propose a new approach to introducing strategies to Iranian travel agencies, but this recommendation tool can be a general model for all travel agencies around the world. An intelligent system that works as an advisory tool and uses reasoning algorithms to plan the trip [11]. Kumar et al., found that the enormous amount of data on the internet has confused users to find their favorable item [12]. Castelli et al., showed that an expert system was developed using a combination of the latest e-commerce parameters based on communication information technologies and psychological knowledge to manage users' preferences and categorize them. Their proposed method seeks to solve the shortages and problems of previous systems [13]. Chikhaoui et al., showed that expert systems are widely used in e-commerce sites [4]. Esheiba et al., showed that expert systems are software tools and suggestion techniques that help users to find their desired item. There are two main types of expert systems: 1- Collaborative filtering expert systems and 2- Content-based filtering expert systems. One of the main problems with collaborative filtering Expert systems is the problem of Gray- Sheep users. Such a problem is related to users whose interests do not match which any group of users. As a result, these users do not receive any suggestions. Therefore, using clustering algorithms, they should first be considered in separate clusters and then generated using text sorting algorithms [14]. Ter´an and Meier showed that expert systems provide personalized suggestions from existing information that play an important role in systems such as e-commerce. Their goal was to design a cluster-based refinement proposal based on cumulative-fuzzy clustering that instead of comparing the user to all users of the system compared each user to a relevant cluster [1]. Kumar et al., investigated the expert systems use the opinions of a group of users. In this study, it is attempted to discuss the most important approaches proposed to improve the performance of the Expert systems [15]. Lun and Li, identified and prioritized factors influencing the development of online shopping for sports goods. The results of one-sample t-test showed that all factors had a significant impact on the development of online shopping. Prioritization of factors was done by AHP method [16].

Guo et al., demonstrated that the Expert system is recognized as a superior way to solve the problem of transferring personal information. Experimental results in the real data from "amazon.com" showed that their model can be useful in predicting ranking [17]. Jiang et al. tried to maximize customer satisfaction. They used an innovative classification model for this purpose [18]. Dobrowski and Acton, examined the effect of preferential relaxation on users' decision making in web-based preference search environments, and their results provided new insights into the positive impact of restrictive soft preference relaxation techniques on decision quality and effort. In fact, they have expanded previous studies on the subject [19]. Kim et al., Have investigated the behavior of customers using decision tree analysis [20].

With the advent of technology in today's world, online stores are gradually replacing traditional and physical stores. Traditional stores need professional marketers as well as different expertise to attract more customers. This can be problematic in many ways. This can make marketers tired and they need to regularly update their expertise. At the same time, relying solely on marketers' experiences may not cover all the needs of customers. Many studies have examined the preferences of customers from the point of view of sellers and manufacturers [21, 22]. But in a limited number of studies, customer selection strategies and key selection metrics have been addressed [23]. That's why expert systems have emerged in online shopping to help the buyer achieve their goal. This system can help as a decision support for the right choice.

The research is organized as follows: In Section 2 The conceptual model is discussed and the structure of the expert system is described. The section 3 describes how to design an expert system. In section 4, the validation of the Expert system is recommended and in Section 5 the data has been analyzed. Finally, conclusions are drawn and suggestions for model development for future research are presented.

2. Conceptual Model

The conceptual model of research is a model that illustrates the reality of designing an expert system to improve user decisions in online shopping and describes certain aspects of the real world in e-commerce and online shopping that are relevant to the issues under consideration. It depicts, and illustrates, the important relationships between the various aspects of the components that influence the design of this system. The key variables used in this paper are extracted using literature review. The rational logic and conceptual model used in this research project is illustrated in Figure (1):

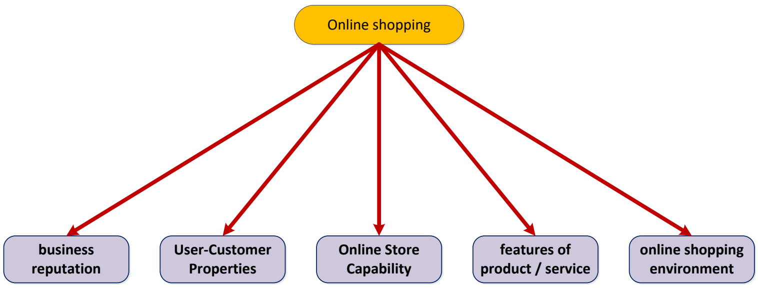

Fig. 1. Conceptual Model Design of a Fuzzy Expert system to Improve User Decisions in Online Shopping

According to the application of the fuzzy expert system designed in this paper, at the end of the five steps, a fuzzy expert system was designed to improve user decisions in online shopping. Using a literature review, five steps were considered for this study. These five steps are outlined below. The proposed structure of the proposed research is presented in Figure (2), followed by interpretive explanations of the five steps.

1. *Modeling the concepts of consumer decision making in online shopping and identifying the input/output components and their relationships.*
2. *Defining qualitative components using linguistic constraints and assigning numbers and fuzzy sets and membership functions.*
3. *Expert knowledge extraction and evaluation by experts and creation of fuzzy rule base and inference engine design.*
4. *Designing the user interface and how to display the options and how to use the fuzzy Expert system.*
5. *Selection of a fuzzy debugging method to convert fuzzy sets to a definite value to evaluate system performance.*

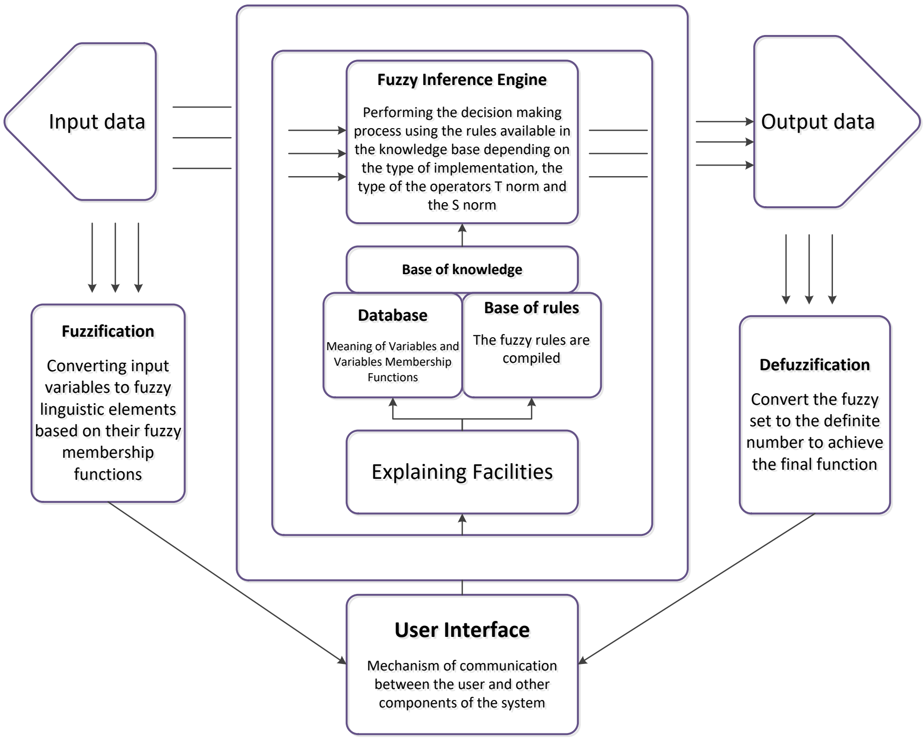

Fig. 2. The structure of the proposed fuzzy expert system

Step 1: Input components fuzzy Expert systems of the present study are, first input component is Business reputation; Second Input Component is the Web Store Capabilities; Third Input Component is Product Specifications; Fourth Input Component is Customer / User Characteristics and the fifth input Component is E-Commerce Environmental. And the output component of the fuzzy Expert system in the research is the design of a suggestion system to improve user decisions in online shopping.

Step 2: Define Qualitative Variables Using Linguistic Constraints and Assign Numbers and Fuzzy Sets and Membership Functions to them, Table (1) and the form of the linguistic variables, fuzzy values, and the membership functions of the triangular and trapezoidal numbers associated with the input and output variables of the fuzzy Expert system are presented in three and five spectra, respectively:

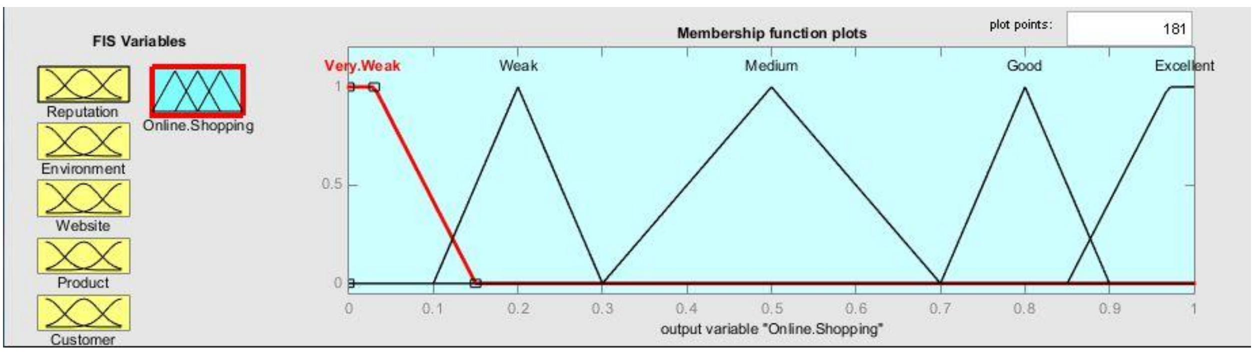

Fig. 3. The configuration of fuzzy Buzzer Output System with fuzzy linguistic variables

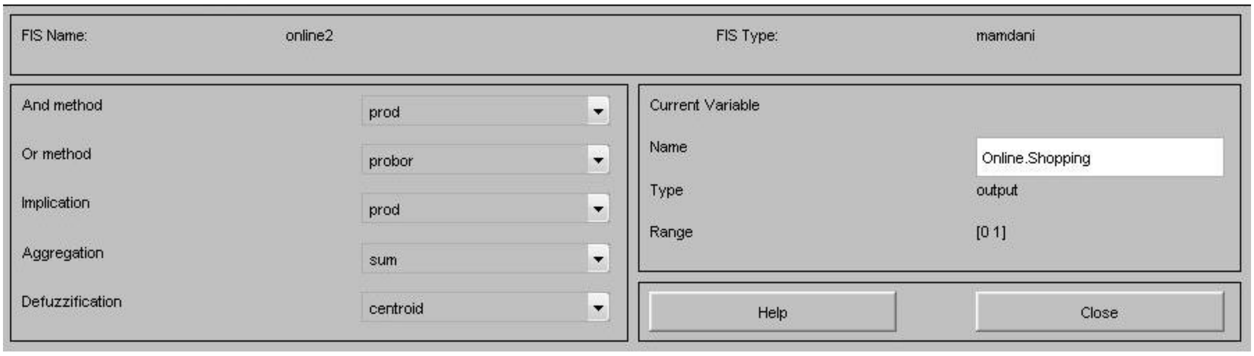

Fig. 4. O.SHOPPING + FRS System inference engine

Step 3: Designing the Knowledge Base of the Fuzzy Expert system, this stage involves extracting the expert rules and evaluating them from the experts and creating the fuzzy rules database. The fuzzy rule base is a set of "if-then" rules that are at the heart of the O.SHOPPING + FRS system, as other components of the fuzzy Expert system are used to implement these rules effectively and efficiently. In this study, the probability of different states occurring between the main variables of the same fuzzy Expert system is considered. The starting point of building a knowledge base in a fuzzy Expert system is to acquire a set of fuzzy “if- then” rules from the knowledge of the person or field of knowledge under study. The next step is to combine these rules into a single system.

Table 1. Linguistic variables used for decisions making improvement in online shopping

Linguistic Variable	Membership Functions Of Triangular And Trapezoidal Numbers
Very Weak	(0.15, 0.03, 0)
Weak	(0.3, 0.1, 0.2)
Medium	(0.7, 0.5, 0.3)
Good	(0.9, 0.8, 0.7)
Excellent	(1, 0.97, 0.85)

Step 4: O.SHOPPING + FRS Inference Engine Design, at this stage, the Centroid method for defuzzification is chosen in order to convert the fuzzy numbers and sets to a definite value to verify the actual performance of the system.

Using MATLAB software we can deduce the rules based on the O.SHOPPING + FRS knowledge base system. In fact, the most important reason for using the Mamdani inference engine (instead of Sugeno) is that in the Sugeno inference engine the selection part of the type of output has been deactivated and it has been combined with fuzzy rules (in order to compute the fuzzy rules for inference and result). Prod is used to select the type of query in MATLAB software because the Min operator shortens the output fuzzy set. The non-phase instrument in the O.SHOPPING + FRS system converts the fuzzy output to a definite number. In the non-fuzzy part of the MATLAB software, the central method is used because it helps reduce the complexity of the problem and also less time for computation. Here, due to the fuzzy rules of the system using the "And" operator, in MATLAB software we select the "Sum" fuzzy rules. In this case, the more accurate sum of each set of outputs is considered, not the maximum.

Step 5: Describes how to use the fuzzy Expert system and analyze its outputs, In order to analyze the output of the system “Improving User Decisions in Online Shopping" O.SHOPPING + FRS, the output of O.SHOPPING + FRS can be either numerically (precisely) or linguistic analyzed. Following figure analyzes the behavior of input variables and output variables of O.SHOPPING + FRS system.

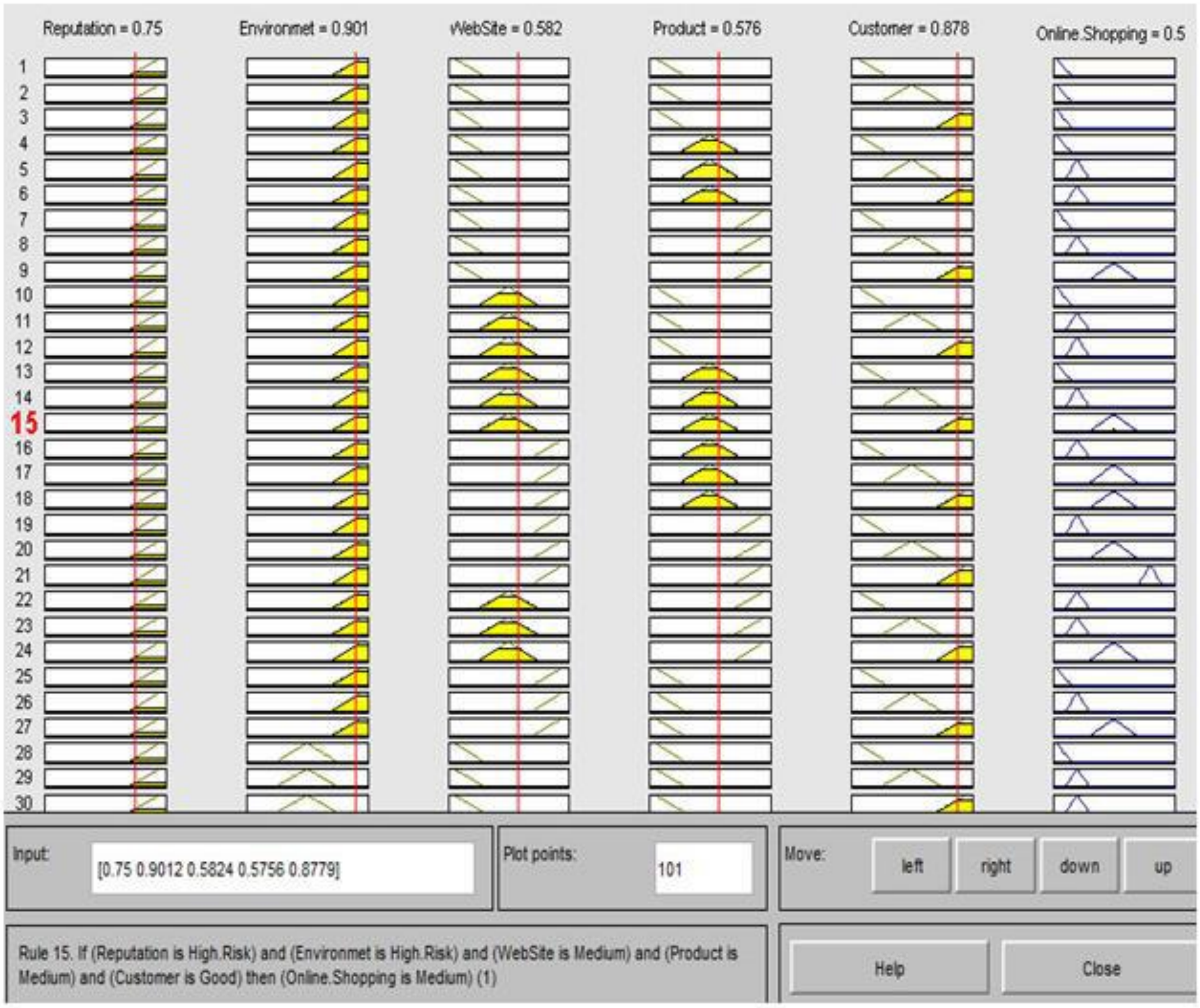

Fig. 5. Numerical and Linguistic Behavior Analysis of "Improving User Decisions in Online Shopping"

In this study, by using the O.SHOPPING + FRS system outputs, the situation of "Improving User Decisions in Online Shopping" can be analyzed based on variables such as "Product / service Specifications", "User / Customer Features", "Online Store Features", " Analyze business reputation " and " e-commerce environment factors ". for example: if " business reputation" status is poor and "e-commerce environment" status is normal and "online store capabilities" are good and "Product / Service Specifications" is good and "Customer / Service Specifications" is normal; then the status of "Improve User Decisions on Online Shopping" would be at the third level that means "Average".

More precisely, using the designed fuzzy Expert system one can also numerically and precisely check the status of "improving user decisions in online shopping": for example, if the "business reputation" status is poor, i.e. exactly 0.15, and "E-commerce environment factors" are in the normal state, i.e. Precisely 0.5; and the “Online store capabilities” are good, i.e. exactly 0.85. And the" Product specifications of the service" are good, i.e. exactly 0.85 and the "Customer user characteristics" are normal, i.e. exactly 0.5; then the level of "improved online shopping decisions" is at the "average" level, i.e. exactly 0.4648 that is shown in Table (2).

Table 2. Numerical and linguistic variables and expert system output

Input			Output		
Variable	Numerical	Linguistic	System Result	Numerical	Linguistic
Business reputation	0.15	Weak	User decisions in online shopping	Medium	0.4648
Internet store capabilities	0.85	Good			
Product / Service features	0.85	Good			
Customer / User features	0.5	Medium			
E-commerce environment factors	0.5	Medium			

3. Design of O.SHOPPING + FRS system

In the present study, the fuzzy Expert system in order to improve user decisions in online shopping was designed by the help of Fuzzy toolbox of MATLAB software and it has been presented under the name of" O.SHOPPING+FRS" in this study. Given the application of the designed fuzzy Expert system, at the end of the five steps for designing a Expert system to improve user decisions in online shopping, the following are included: First step: Identifying the input and output variables of the system: After finalizing the fuzzy Expert system conceptual model was used to define the input and output variables of the fuzzy Expert system. Fuzzy Expert system Input variables to Improve User Decisions in Online Purchasing Using MATLAB's Fuzzy Toolbox, entitled O.SHOPPING + FRS, includes: First input variable: Business reputation status; Second input variable: E-commerce environment status; Third input variable: Web store capabilities; Fourth input variable: Product Service specifications; Fifth Input Variable: Customer / User Features and system output variable in the fuzzy expert system is to improve user decisions in online shopping. Considering the conceptual model as well as the expert observations used to evaluate the model, the input and output variables of the fuzzy Expert system can be shown as follows.

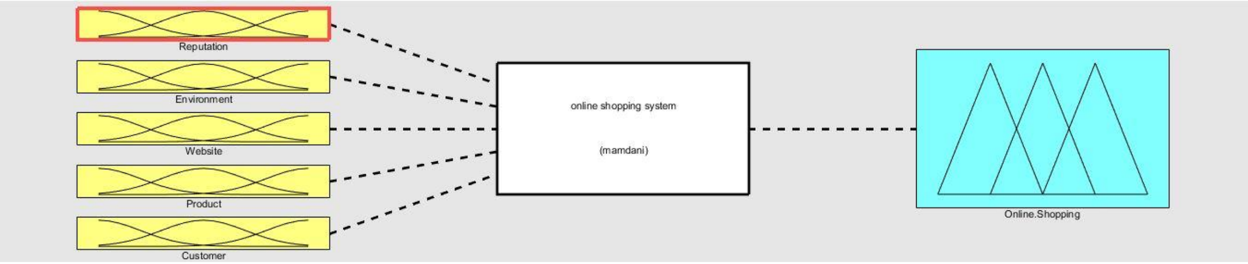

Fig. 6. "Improving User Decisions" module, Input Variables Model

How to generate the main module Knowledge Base Rules in the O.SHOPPING + FRS system is based on the following steps:

A: Calculate the weight of each of the main variables using expert Opinions. These weights are shown in Table (3).

Table 3. Weighted Information for main variables

Research Variables	Weighted Average	Ultimate Weighted Variable
Product / Service features	5.694	0.814
Customer / User features	5.692	0.813
Internet store capabilities	5.734	0.819
Business reputation	5.734	0.819
E-commerce environment factors	5.720	0.817

B: Calculate the amount of output variables based on the weight of each variable: Considering the weight of each of the input variables of the fuzzy Expert system the "improving user decisions in online shopping" in different modes could be evaluated. Here, the probability of different states occurring between the main variables of the fuzzy Expert system is considered. In fact, after interviewing the experts in the field under study, we can produce fuzzy rules based on Table (4):

Table 4. calculations related to weight in probabilistic states for knowledge base rules in the fuzzy expert system

Possible Modes For Generating The Rule	Weight Of Each Variable * Definitive Value Of The Linguistic Variable	Assumed State Weight
If " business reputation" status is Weak (High Risk)	0.807*0.15 (Inverse relationship (1 – 0.85))	0.12105
And "e-commerce environment" status is normal	0.817 * 0.5 (Inverse relationship (1 – 0.05))	0.4085
And "online store capabilities" are good	0.819*0.85	0.69615
And "Product / Service Specifications" is good	0.814*0.85	0.6919
And "Customer / Service Specifications" is normal	0.813*0.5	0.4065
Thus what is the status of “Improve User Decisions on Online Shopping"?		Assumed mean state weight: 0.4648

According to the linguistic variables membership functions provided by the experts in the Table, 0.4648 is defined in the interval defined for the "average (ordinary)" linguistic variable. Therefore, the state of improvement of user decisions in online shopping in above is at the level of "average (ordinary)". The linguistic variable is defined as "average (ordinary)" therefore the state of improvement of user decisions in online shopping is in the level of "average" that means normal. Other rules of the knowledge base of this fuzzy Expert system were also produced. Finally, since the module "Improving User Decision Making in Online Shopping” in O.SHOPPING + FRS system has 5 variables that each variable has 3 modes (Low Risk, Medium, and High Risk) therefore the number of fuzzy rules would be 243 rolls. Figure (7) shows the fuzzy rules module bases in O.SHOPPING+FRS.

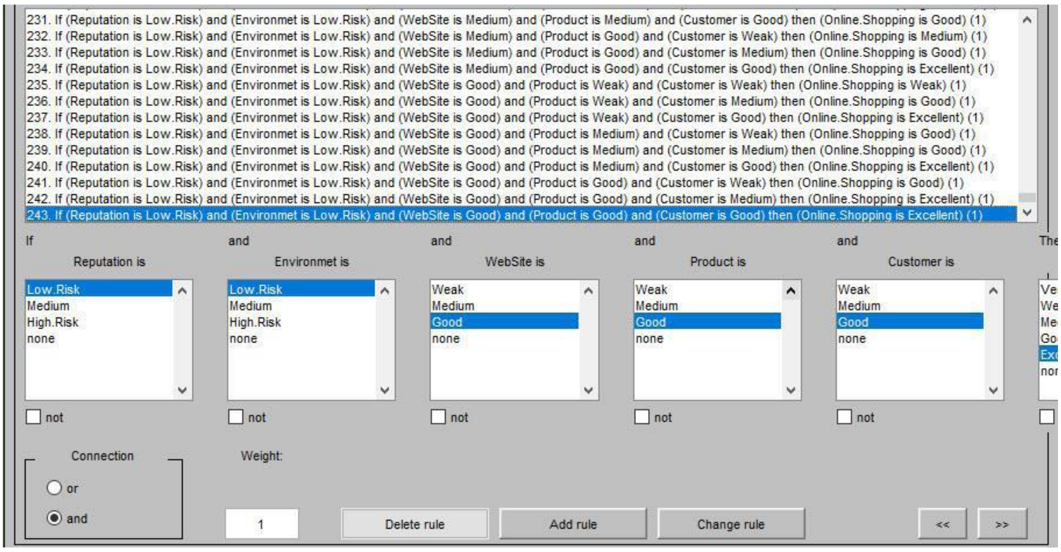

Fig. 7. How to Generate Fuzzy Rules within the “E-Commerce Online Shopping” Knowledge Base Module

4. Final Evaluation of Fuzzy Expert System Responses

After designing the fuzzy Expert system, the outputs and solutions of the fuzzy Expert system were compared in a separate measurement tool with the opinions of 18 experts; the results have been summarized in Table (5) were according to the rules of fuzzy expert system the average opinion of experts can be seen.

Table 5. Comparing "O.SHOPPING+FRS" Outputs with Average Expert Opinions

Fuzzy Advisory System Rules	Fuzzy Advisory System Outputs	Average Expert Responses	Ratio Of Difference	The Final Difference
Rule. 3	1	1.22	0.055 = 4/0.22	
Rule. 45	3	2.72	0.0675 = 4/0.28	
Rule. 79	3	2.78	0.055 = 4/0.22	
Rule. 86	2	1.67	0.0825 = 4/0.22	
Rule. 103	2	1.67	0.0825 = 4/0.22	0.06475
Rule. 140	3	2.78	0.055 = 4/0.22	
Rule. 157	3	3	0 = 4/0	
Rule. 219	2	2.94	0.015 = 4/0.06	
Rule. 224	2	2.39	0.1525 = 4/0.61	
Rule. 235	2	2.67	0.0825 = 4/0.33	

Assumption Zero (H0): There is a significant difference between the mean of expert opinions with the output of "O.SHOPPING + FRS". Contrast assumption (H1): There is no significant difference between the mean of expert opinions and the output of "O.SHOPPING + FRS". According to the descriptive information in the above Table, one can compare the outputs of the fuzzy Expert system, O.SHOPPING + FRS, with the average of expert opinions. Since the experts' opinions are expressed on the basis of the Likert 5 spectrum (1 to 5), in order to test the above hypothesis one can use the percentage of discrepancy between the outputs of the fuzzy Expert system, O.SHOPPING + FRS, with the mean of expert opinions as follows. . As can be seen, the final difference between the outputs of the fuzzy Expert system, O.SHOPPING + FRS, and the mean of expert opinions was not significant and was equal to 0.06475. Since there is no good reason to accept the null hypothesis, the opposite assumption is accepted, meaning that there is no significant difference between the mean of expert opinions and the outputs of the "O.SHOPPING + FRS" system.

5. Data Analysis

In order to design an Expert system to improve user decisions in online shopping using the Fuzzy Toolbox of MATLAB software, they are thoroughly analyzed. Based on the opinions and experience of Managers and IT executives and experts in e-business and online stores as well as academics, the weighted average of the affecting criteria on "business reputation" was equal to 5.651; the weighted average of the importance of affecting criteria on " Internet store capabilities" was equal to 5.734; weighted average of importance affecting criteria on "product /service characteristics" was equal to 5.694; the weighted average of importance affecting criteria on "user /customer characteristics" was equal to 5.692; and weighted importance criteria "Environmental factors of e-commerce" was Calculated equal to 5.720; while balanced situation of influenced criteria on "Business Company reputation" was equal to 4.628;balanced situation of affecting criteria "Features of Online Shop" was 4.710; Balanced situation on Influential criteria Status on "Service/ Product Specifications" was equal to 4.723; Balanced situation of the "User / Customer Specifics" was equals 4.648 and the weighted criteria affecting the "E-Commerce Environmental Factors" was equals 4.663. Here the Cronbach's alpha for the research variables is greater than 0.8, indicating that the reliability of the measure of the influence of variables affecting the improvement of user decisions on online shopping is in excellent condition, as shown in Table (6). In fact, according to the statistical analysis of the present study, in order to investigate the impact and influence of the dependent variable and the independent variable, use of Pearson correlation coefficient based on *the research variables.*

Table 6. Reliability status of research variables

Research Variables	Cronbach's Alpha	Number Of Items
Business reputation	.949	15
Internet store capabilities	.955	16
Product / Service features	.963	17
Customer / User features	.974	20
E-commerce environment factors	.971	21

Since the correlation coefficient is the slope of the regression line, there is a positive and significant relationship between electronic loyalty and intercourse quality with customer. Because Pearson's correlation coefficient between them was calculated to be 0.79, there was a positive and significant relationship between electronic loyalty and ability to order, because Pearson's correlation coefficient between them was calculated to be 0.955. There is a positive and significant relationship between the attractiveness of sponsors towards the organization and interactivity, as the Pearson correlation coefficient is calculated as 0.552. Whereas, there is a positive and significant relationship between customer age and interactivity, because Pearson correlation coefficient between them is calculated to be 0.987, and there is a positive and significant relationship between economic factors affecting e-commerce and purchase risk, because Pearson correlation coefficient between them was calculated to be 0.664, and there is a positive and significant relationship between customer gender and interactivity, as Pearson correlation coefficient between them was calculated to be0.995. On the other hand, there is a significant positive relationship between the timely delivery of goods and the ability to place an order, as the Pearson correlation coefficient between them is calculated as 0.654, and there is a positive and significant relationship between after-sales service and purchase risk, as the Pearson correlation coefficient was calculated to be 0.582. There was a significant positive relationship between customer age and purchase risk, as Pearson's correlation coefficient was calculated to be 0.664. Plus, there is a positive and significant relationship between customer gender and purchase risk, as Pearson's correlation coefficient is calculated as 0.602, and there is a positive and significant relationship between network and telecommunications performance status and choice of on-site and online payment methods, while Pearson correlation between them is calculated as 0.955. In fact, given the high correlation between the variables and research indicators, namely business reputation, online store capabilities, product/service characteristics, user/customer characteristics and environmental factors of e-commerce, one can comprehensively integrate user decisions in online shopping.

Figure (8) shows the relationships between inputs and output. As such, the Z-axis represents the output and the X and Y axes represent the inputs. In fact, we need five graphs to ensure that all entries are parsed. The first two inputs, "business reputation" and "Internet store capabilities", can be seen in Figure 8a. According to this Figure, the output is more sensitive to the second input than the first input. This means that the second input can be of greater importance. This is because more space is covered in the top area of output. This result is consistent with previous analyzes. For the other inputs, one can provide such an analysis as can be seen in Figures 8b to 8i.

6. Conclusions and future Research

In the research on "Designing a fuzzy Expert system to improve user decisions in online shopping" one of the most important findings is that, according to the difference between "importance" and "status" that are critical to improving a user's online shopping decisions, here business managers and IT experts and webmasters need to pay a special attention towards operational status and variables such as "business reputation" variable; "online store capabilities" variable; "product / service specification" variable; "user / customer specification" variable; "E-commerce environment factors" variable. Here, using outputs from O.SHOPPING + FRS system, one can analyze the status of "improving user decisions in online shopping" based on inputs. The fuzzy Expert system, O.SHOPPING + FRS, and the average expert opinion were not meaningful and it was equal to 0.06475. Here, using O.SHOPPING + FRS system outputs, one can adjust the status of "Improving User Decisions in Online Shopping" and analyzed based on variables such as "Product / Service Specifications", "User / Customer Features", "Online Store Features", "business reputation" and "environmental factors of e-commerce": if the status of "business reputation" is poor and "factors E-commerce environment" is normal and "Internet store capabilities" are good and "product / service features" is good and "user / customer features" are normal, then "improve user decisions in online shopping" in the third Its level is "average". More precisely, using the designed fuzzy Expert system, the "status" of improving online shopping decisions can be numerically and more precisely checked: The "business reputation" is weak, i.e. exactly 0.15, and the" E-commerce environment factors" are in the normal state, i.e. exactly 0.5, and "Internet store capabilities" is good, i.e. exactly 0.85 and "Product / Service features" is good, that is exactly 0.85, and "Customer / User Features" is normal, exactly 0.5; therefore the "improve user decisions in online shopping" is average (regular) and is exactly 0.4648. There are also suggestions for future research including: Other artificial intelligence techniques, especially artificial neural network and most importantly the most relevant algorithms in the field of artificial intelligence, to enhance the content richness of the system and improve its fuzzy inference process to improve user decisions in online shopping, as well as to use fuzzy multidimensional decision (MCDM)-making techniques to rank the network relationships between models and improve user decisions in online shopping.

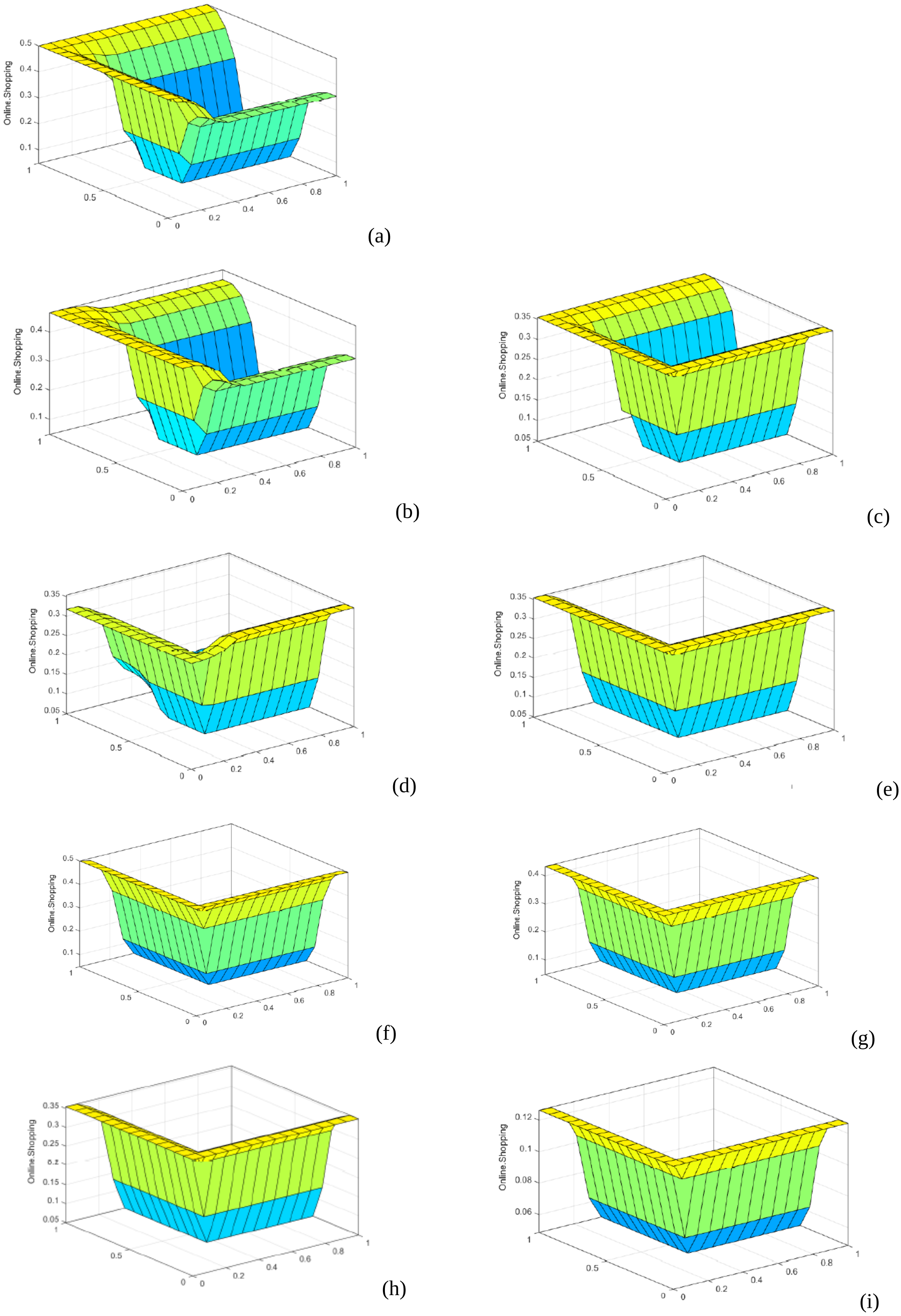

Fig. 8. Levels of Fuzzy Inference System

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