Fuzzy based Decision Support System for E-tourism Investment Risk Analysis

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ABSTRACT

This system presents fuzzy logic based decision support system for E-tourism investment risk analysis. E-tourism is the part of e-commerce that helps to generate new opportunities to increase demand for product and services, and improve management capabilities in tourism sector. E-tourism is the use of Information and Communication Technology (ICT) in tourism which may allow operating tourism in least variable cost, least time and increasing work efficiency. There are many factors that affect to the development of E-tourism. To demonstrate the effectiveness of the system, four factors are considered. These are amount of investment, human skill, E-tourism infrastructure and instability of the regions. Using fuzzy logic technique to solve the problem of vagueness and uncertainty, it is now become important tool for decision making. These parameters are fuzzified and a fuzzy rule-based has been developed for calculating risk factor for the E-tourism investment.

1. INTRODUCTION

Tourism is a crucial role for the developing and underdeveloped countries in order to earn much foreign currency and generate more employment. Tourism has supported 195 millions of jobs globally. The use of information and communication technology (ICT) has boomed in many sectors, such as business, education, commerce etc, all over the world. E-tourism is the terminology which is generally used to represent the use of ICT in tourism sector to promote and facilitate E-tourism services [1].

Fuzzy logic technique is used to solve the problem of vagueness and uncertainty and it is now become important tool for decision making. Fuzzy rule based approach has gained achievement in the field of business and engineering application, eco-system management, fuzzy multi criteria decision making is used in evaluation of airlines services quality and also used in fuzzy uncertainty analysis in political forecasting and in the similar way has used fuzzy logic based loan risk analyzer for the banking sector[4].

The decision support system may help decision makers to analyze the risk associated with E-tourism investment in a particular situation of a region. A risk analysis tool has been developed using fuzzy rule based approach. The decision support system takes some influencing factors on investment decision in E- tourism sectors, and calculates a risk factor as a recommendation whether the investment can be made[3].

2. RELATED WORKS

Many tourism organizations are confronted by an ever increasing pressure to find new ways to complete effectively in a dynamic global market. Many are turning into e-commerce and virtual structure using e-facilities to expand into global market. The demand for tourism product and services on the internet has been growing, like the number of internet users and speed of access to the internet. The availability of new technologies leads to the development of new skills, new materials, new services, and new forms of organization. In

tourism, E-tourism has created a new form of business as an important part of e-commerce.[3]

3. FUZZY BASED DECISION SUPPORT SYSTEM

Decision support systems are the tools that help to decide either simple or complex decision problem. It is used for different decision making. A decision support system presents information graphically and may include an expert knowledge or artificial intelligence. It is a specific class of computerized information system that supports business and organizational decision-making activities. A properly designed DSS is an interactive software-based system intended to help decision makers compile useful information from raw data, documents, personal knowledge, and/or business models to identify and solve problems and make decisions. Decision-support systems are interactive computer-based tools used since the 1960s by decision-makers to help answer questions, solve problems and support or refute conclusions. A decision support system is a highly flexible and interactive Information Technology system which has a purpose of supporting decision making when the problem is not structured. Figure 1 shows the basic structure of fuzzy decision models [3].

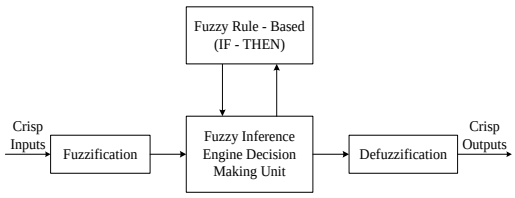

Figure1. Basic structure of decision support system

Rule-based systems represent human knowledge use of "IF-THEN" rules. Fuzzy sets allow representing the membership functions as a possibility distribution; also offer heuristic solutions to real-world problems and the possibility of multiple solutions. The fuzzy rule based system uses four input variables and one output variable.

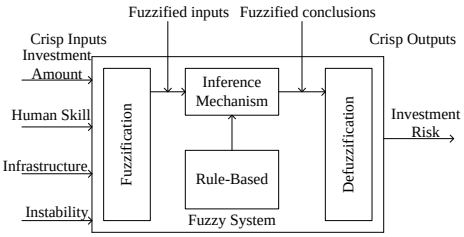

Figure2. System design using fuzzy approach

4. PROPOSED SYSTEM ARCHITECTURE

There are two main parts in this system. These are preprocessing and fuzzy rule based decision making system. This system is used for decision of investment risk for E-tourism.

4.1 Identification of the Influencing Factors

In the process of designing a fuzzy investment risk analyzer the first most important task is to identify those factors that contribute primarily to the investors' risk associated with their investment for E-tourism facilities. The four main factors are identified: investment amount, human skill, E-tourism related infrastructure and stability of the given region. These parameters are used as inputs to the risk analyzer.

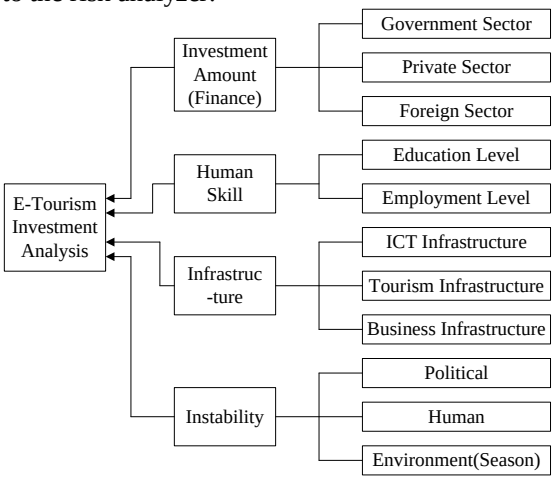

Figure3. Organizing parameters to determine the fuzzy input variables

4.1.1 Investment Amount

Investment is the most important and necessary factor for development. In this system, the total investment amount is the sum of these three funds.

Government investment (GI) has given priority, private investment (PI) and foreign investment (FI) according to their importance and their influences. The global weights of the government investment is given 50 percent weight while private and foreign investments are given second and third priority with 30 and 20 percent weight respectively. It is also assumed that the local weights of the government investment, private investment and foreign investment will invest 10, 10 and 5 percent of their total investment amount. On the basis of these assumptions a formula is derived using weights given in three investments with respect to percentage of total investment amount available for investment in E-tourism.

Investment amount = Percentage of GI*5 + Percentage of PI*3 + Percentage of FI*4 (1)

This formula gives a normalized investment amount available for E-tourism in the scale of 0 to 1, where 0 being no investment available; and 1 being high investment availability.

4.1.2 Human Skills

Assume that the human skill is determined by level of education, rate of employment, nature of the people, age factor and experiences of people. For simplicity two factors are considered: such as rate of education and rate of employment. It is assumed the weight given for education 70% divided by the percentage of education level 50% gives 1.4, while the weight given for employment 30% divided by the percentage of employment level 30% gives 1. So the human skill becomes.

Human Skill = Education Rate*1.4 + Employment Rate*1 (2)

4.1.3 ***Infrastructure***

Infrastructure is another input factor used in the proposed E-tourism investment risk analyzer. The term infrastructure is defined by tourism, ICT and business infrastructures. Their weights are assumed 30, 40 and 30 percents according to their importance respectively.

Tourism infrastructure is determined on the assumption that 50% of tourist arrival use tourist sites, star hotels and hotel/tour agents. It is also assumed that average 30 units of tourist sites, star hotels, tour and travel agents are used for formula derivation.

In ICT infrastructure, the average number of telephone line, average number of computers in use and average number of internet cafe in the region are 200,000, 30,000 and 500 respectively and total population in the region is also 500,000. These values are used to determine formula for ICT infrastructure.

For business infrastructure, 20 percent business use ICT. The different formulae are used to determine ICT, Tourism and Business. Formula for these three sectors is as follows:

1. ICT Infrastructure = 2* Number of Telephone Line Distributed + Number of Computers in the Region*10 + Number of Internet Café Facility *500/Total Population =1.4 (3)

Number of telephone multiplied by two means that one telephone is for 2 people. Number of computers multiplied by ten means one computer for 10 people and number of internet café multiplied by 500 means one internet café for 500 people is acceptable.

2. Tourism infrastructure = Percentage of tourist arrival in the tourist site* number of tourist site + Percentage of tourist arrival use star hotels*number of star hotels + Percentage of tourist arrival use tour and travel agents*number of tour and travel agents = 45 (4)

3. Business infrastructure = Percentage of business use ICT = 0.2 (5)

Infrastructure = value obtained from ICT*0.267 + value obtained from Tourism*0.0067+ Percentage of Business use ICT in their business*1.5 (6)

In the Infrastructure formula, the weighting coefficient 0.267, 0.0067 and 1.5 are determined on the basis of weight given for ICT (0.4) divided

by the value obtained for ICT infrastructure (1.4), tourism (0.3) divided by the value obtained for tourism (45) and business (0.3) divided by the value obtained for business (0.2) in their business respectively.

4.1.4 Instability

To determine stability, three sectors political, human and environmental or weather condition stability are considered. Different stability are defined in terms of our knowledge is given below.

Political Instability (PI):

- Instability prevails by changing rules and regulation.
- Instability prevails by demonstration by the oppositions.
- Instability prevails by international pressures.
- Instability prevails by political instability and civil wars.

Human Resource Instability (HRI):

- Instability prevails by destroying tourist sites.
- Instability prevails by destroying infrastructures.
- Instability prevails by the computer hackers.
- Instability prevails by the unfair competition.
- Instability prevails by the pirating.

Environmental Instability (EI):

- Instability prevails by the natural calamities.
- Instability prevails by the environmental deterioration.
- Instability prevails by the environmental fluctuation (seasonal).

Instability=Percentage of PI*1 + Percentage of HRI1.2* Percentage of EI*0.8t

4.2 Determination of Linguistic Terms and Membership Functions

Linguistic variables are used in fuzzy logic. The fuzzification stage involves converting linguistic variables into fuzzy sets. Triangular functions are commonly applied because of their simplicity, there is a large number of input factors that affect the investment risk determination process. For simplicity these large number of input factors are combined using simple mathematical equations to derive a limited number of parameters. In this application there are four input parameters.

4.3 Normalization of Inputs Parameters

Normalize the values of input parameters within the range of [0, 1]. Min-max normalization performs a linear transformation on the original data

$$v' = \frac{v - \min_A}{\max_A - \min_A}(new - \max_A - new - \min_A) + new - \min_A \quad (7)$$

- maxA = maximum value of an attribute A = 1
- minA = minimum value of an attribute A =0

4.4 Inputs and Outputs Fuzzy Sets

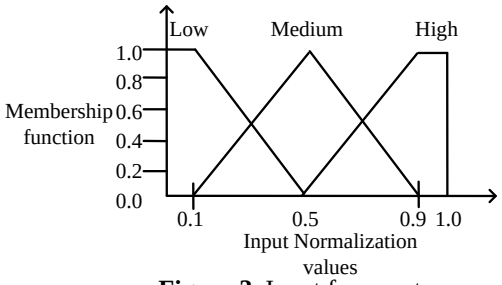

Figure 3. Input fuzzy sets

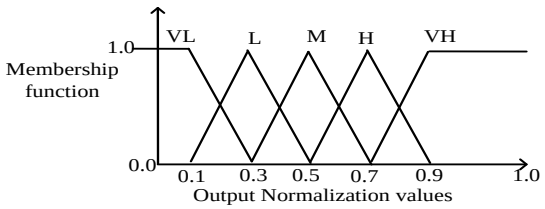

Figure4. Outputs fuzzy sets

There are four inputs parameters and each have three fuzzy sets:

- LOW, MEDIUM and HIGH.

Low and high are shown in trapezoidal membership function while medium is determined in triangular function. In this case the range between [0, 1] is used.

4.5 Fuzzy Rule-Based

The fuzzy rule-base is derived from expert knowledge and own personal view related to E-tourism and historical data. Therefore, there are 81

possible rules. The following is the example of some rules:

Rule 1: If the investment amount = Low, human skill = Low, infrastructure = Low, and the instability = Low, then investment risk = Very High.

Rule 2: If the investment amount = Low, human skill = Low, infrastructure = Medium, and the instability = Low, then investment risk = Very High.

Rule 3: If the investment amount = Low, human skill = Low, infrastructure = High, and the instability = Low, then investment risk = High

5. SYSTEM DESIGN

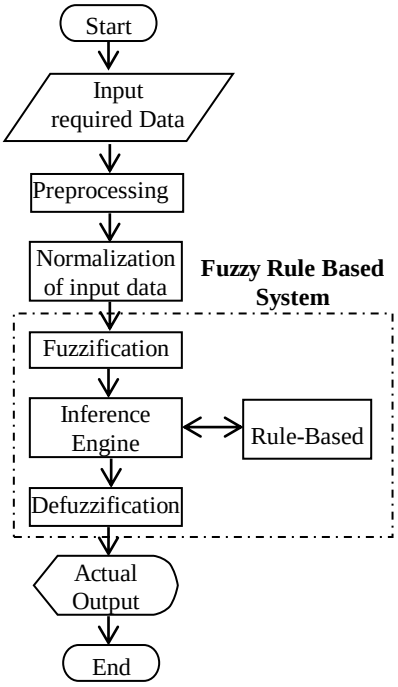

Figure5. System flow diagram

6. SYSTEM IMPLEMENTATION

There are four parts in this system: preprocessing, normalization, fuzzy calculation and fuzzy rule. In the preprocessing steps, investment amount, human skill, infrastructure and instability are calculated in the area of interest.

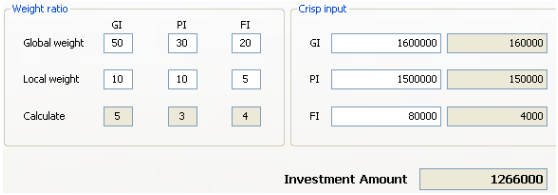

Figure 6.Result of investment amount

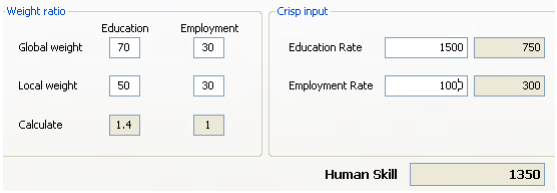

Figure7.Result of human skill

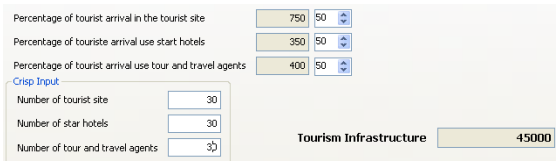

Figure8. Result of tourism

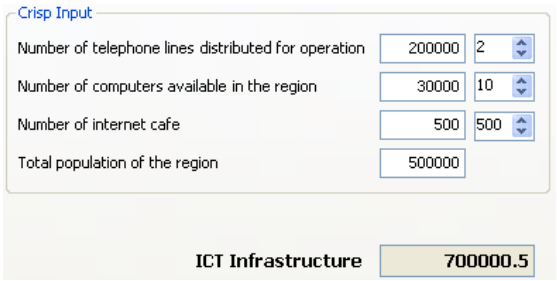

Figure9.Result of ICT

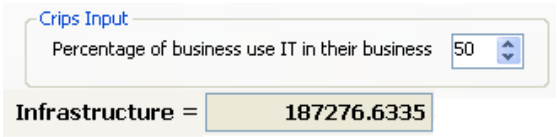

Figure10. Result of infrastructure

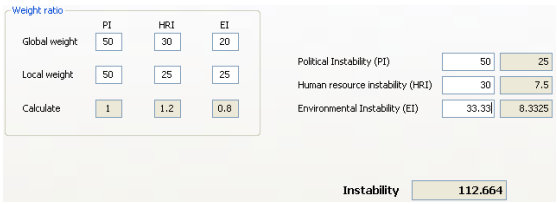

Figure11. Result of instability

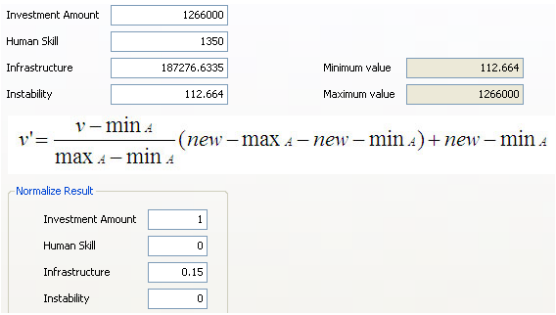

Figure12. Normalization results

Input values calculated from mathematical equations are normalized by using max-min normalization method so the normalized results are obtained between 0 and 1.

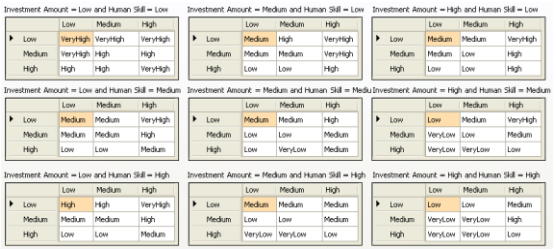

Figure13. Possible 81 fuzzy rules

The system is implemented with possible 81 fuzzy based IF-THEN rules to provide the decision for E-tourism investment risk analysis.

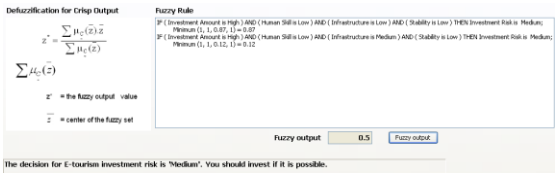

Figure14.Fuzzy output of the system

Since the system is fuzzy rule based decision support system, all the inputs – investment amount, human skill, infrastructure, and instability – were preprocessed and normalized. Depending on the normalized result, the system generates the IF-THEN rules. The antecedents are implicated and the consequents are aggregated by the fuzzy inference engine then the fuzzy output is produced. The fuzzy value is defuzzified into crisp value using centriod method. Finally, the system gives the decision support for E-tourism investment risk which is shown in figure 14.

7. CONCLUSION

The case study above mentioned is intended for developing countries. It is found that the defuzzified crisp value is 0.5. So, the decision supports "the investment possibility is medium with medium risk". In the case study of developed region, the crisp value is 0.7. It gives 'the investment possibility is high with low risk to invest". In addition, for the underdeveloped region, the defuzzified value is 0.2 which gives "the investment possibility is low with high risk". Therefore, E – tourism is growing in developed countries because of availability of resources. Least developed and underdeveloped countries are still beyond the E – tourism development.

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