IJBS VOL. 1, NO. 2, DECEMBER 2018: 106–112 DOI: 10.9744/ijbs.1.2.106–112
E-ISSN 2621-6426

Measurement Model of Tourism Destination Images Using Fuzzy Inference System

Magdalena Wullur[1] and I Nyoman Sutapa[2]
[1] Faculty of Economics and Business, Sam Ratulangi University,
Kampus Unsrat, Bahu, Manado 95115, INDONESIA
[2] Faculty of Industrial Technology, Petra Christian University,
Jl. Siwalankerto 121-131 Surabaya 60236, INDONESIA
E-mail: mantapa@petra.ac.id

Abstract

This article discusses the measurement model of tourism destination images perceived by travelers based on five dimensions of the service quality, i.e., tangibles, reliability, responsiveness, empathy, and assurance. Measurement problems occur when a traveler assesses the quality of a tourism destination service subjectively with vague boundaries and perceives the image of a tourism destination to vary. To address these issues, we designed an inference model using Mamdani's fuzzy inference system. The results of this study are quantitative assessments of the image of tourism destinations by various travelers based on qualitative perceptions of the quality of service experienced by the traveler.

Keywords: Tourism services quality; Mamdani's fuzzy inference system; travelers perception.

1. Introduction

Increasing the competitiveness of the tourism industry can create new sources of economic growth. North Sulawesi, as a case study, based on Tourism Industry Report (2016), North Sulawesi Province has a great potential in the tourism sector which can be utilized to increase economic growth. However, from the field survey, it was found that infrastructure, such as roads, street lighting, communication facilities, and access to tourism objects were inadequate. Environmental cleanliness, an comfort, and safety of tourist destinations are still lacking. Tourism destinations are, to look attractive and sustainably preserved, are generally not managed optimally. As well, human resources as the leading players in the tourism services industry are still not competent enough. If this weakness is not managed well, then the potential for increased economic growth will be difficult to achieve.

The tourism industry is a very complex service industry (Bhat, 2012), involving many players, including hotel or accommodation businesses, travel agents, restaurants, food-beverage retailers, transportation businesses, the government, and local communities. All of these players serve travelers who have varying expectations, experiences, lifestyles and abilities. All travelers want to get a memorable and satisfying service, to stay longer and spend more. To satisfy travelers, one of the essential components of the tourism industry is the image of a tourist destination (Akroush *et al*., 2016). The image of tourism destinations is mainly related to the quality of services carried out in an integrated and systematic manner by all tourism players. Managing the tourism service industry by involving many players, in serving the various desires and needs of the traveler, requires an integrated management system approach. One management system that can be applied is Total Quality Management. In this study, not all components of TQM are studied, as the initial step of the study is limited to determine the measurement or indicator of service quality and its relation to an indicator of the image of a tourism destination. The measurement is important to study, to get an overview of the expectations and perceptions of the traveler based on the experience of visiting objects or tourism destinations. Decision-makers can use this service quality measure as a monitoring and evaluation tool in improving service quality in the tourism service industry (de Ona *et al*., 2016).

Furthermore, data which is a measure or indicator of service quality experienced by travelers is generally not much and incomplete is delivered systematically to tourism decision makers. No much travelers want to express their experience in a tourist destination, also if there is, usually not much data or information is conveyed. Lots of data or information are scattered only as a moving story. This is because there are not many officers and media to collect data or information from the traveler. If there are a data collection media, only for the limited needs of the company, not much information has been shared for the shared needs of the players (Frias *et al.*, 2013; Said *et al.*, 2013). Furthermore, the data or information submitted by the traveler is generally subjective

and qualitative, namely in the form of words or statements that are vague or inexact. The other side, the data or information of the traveler, the type and form vary and continues to increase in line with the number of tourists (Sreekumar *et al*., 2015).

2. Literature Review and Methods

Fuzzy inference system (FIS) is a process of formulating the mapping from a given input to output using fuzzy logic (Zadeh, 1996; Sabri *et al*., 2013). The mapping provides a basis from which decision can be made. FIS is sometimes called fuzzy reasoning, used in a fuzzy rule, to determine the rule outcome from the given rule input information. Fuzzy rules represent modeling knowledge or experience. Fuzzy rules are needed to compute the outcome for output variables in consequence of the rule when specific information is assigned to input variables in the rule antecedent. The main components of FIS include fuzzification interface, inference engine and defuzzification (Sabri *et al*., 2013). A basic structure of FIS that comprises three components and rules can be seen in Figure 1.

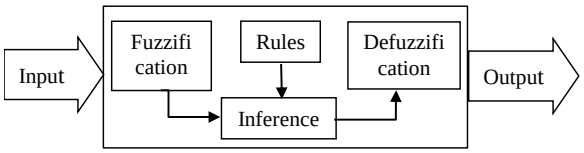

Figure 1. Basic Structure of a Fuzzy Inference System

FIS can be envisioned as involving a knowledge base and a processing stage. The knowledge base provides membership function and fuzzy rules needed for the process. In the processing stages, crisp numerical variables are the inputs of the system. These variables are passed through a fuzzification stage where they are transformed into linguistic variables, which become the fuzzy input for the inference engine. This fuzzy input is transformed by the rules of the inference engine to fuzzy output. A defuzzification stage then changes these linguistic results into numerical values that become the output of the system (Sabri *et al*., 2013). Creating a decision using FIS involved several steps. The steps in FIS are created to develop inference for the tourism destination image (output) based on service quality dimensión (input). There are five dimensions of service quality, namely tangible, reliability, responsiveness, assurance, and empathy, that may influence the tourism destination image. In Table 1, identify the indicators for each dimension of service quality and tourism destination. Mamdani inference system (Mamdani and Assilian, 1975), allows a system to take in a set of input values and apply a set of fuzzy rules to those values, to derive a quantitative output value (Figure 2). The data or information from service quality dimensión become the inputs of the Mamdani inference, and the output of the system is the tourism destination image. Figure 2 illustrates the processes to transform inputs into an output.

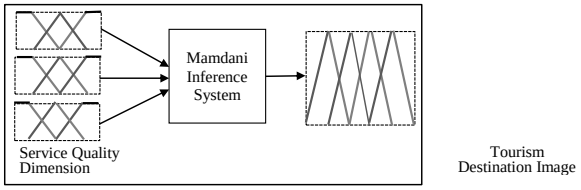

Figure 2. The transformation from the Input to the Output of the System

3. Design of Measurement Model for Tourism Destination Images Using Fuzzy Inference System

3.1. Output and Input of the System

The output of the inference system is a tourism destination image. Based on Hankinson, (2005) and Kim *et al*., (2013), the data for the system outputs are taken from the answer to the question according to image indicators, i.e., the destination environment attractiveness, easy access to tourist places in the destination, traveler enjoyment of the style of the building in the destination, adequate of transportation in the destination, the residents friendliness of the destination, and the residents of the destination are excellent and welcoming to travelers. The data for the system inputs are taken from the indicator of service quality dimension (Table 1), the dimension and its indicators are derived from previous research (Bhat, 2012; Akroush *et al*., 2016; Parasuraman *et al*., 1988). The information can be collected from back pocket of an airplane, airport waiting room, hotel lobby, restaurant, information office of tourism destination, and via many resources, for example via questionaries' to the traveler, checklist button at hotel/restaurant toilet.

Based on the defined system functional and operational characteristics, input and output data from now on referred to as system variables, are needed to fuzzify. The following steps are executed to obtain tourism destination image based on service quality dimension.

3.2. Fuzzy Membership Function of System Variables

System variables are fuzzified to obtain a fuzzy membership function. The system recognizes the input and output variables and defines its membership. In this research, all membership function for

Table 1. Service Quality's Indicators for Input Variable

Dimension	Indicators
Tangibles	The infrastructure is designed with high-quality standards
	Modern and technologically relevant vehicles were available.
	Enough security guards and provide security and comfort.
	The meals that were served are of high quality.
	The accommodation and facilities were appealing and in sound design.
	The physical appearance of the hotel was tidy and clean.
	The physical appearance of the tours escort was tidy and clean.
	There is free Wi-Fi internet with large bandwidth.
	There is an adequate supply of electricity.
	There is an adequate HP charger facility.
	There are enough volunteer photographers for a selfie or groupie.
	Traveler information officers are easy to find
Responsiveness	Tourism servicer showed sincere interest in problem-solving
	Tourism servicer provided adequate and clear information about the service they deliver
	Tourism servicer was able to fulfil requests promptly on time.
	Tourism servicer provided full information regarding the entertainment offered.
	Tourism servicer showed sincere willingness and interest in helping/assisting.
	Tourism servicer provided advice on how to best utilise free time
Empathy	Services offered were supplied by pleasant and friendly personnel
	My exceptions and special needs were met as expected.
	Personal safety was considered a significant aspect of every service provided.
	Local people care about and pay attention to traveller needs.
	Tourism destinations pay attention to the needs of disable traveller
Assurance	Well-Trained, customer-oriented personnel serves the traveller
	The level of service quality reinforces traveller confidence in the service provided.
	Detailed, experienced and competent tour/hotel escorts were provided to facilitate traveller.
	Staff communicated with fluently and in an understandable manner.
	All food and beverages sold are certified according to international standards.
	There is an OK sign from the results of the food and beverage audit conducted by the authorities.
	Every traveller infrastructure has been audited regularly and has passed the authorised institution
Reliability	Directions and signs were available properly
	Directions and signs easily guided me in finding the needed locations.
	Services delivered were correct from the first time.
	Services were delivered as promised to travellers.
	Scheduled tours were met on time.
	No troubles occurred with the service provided during my stay.
	Information from taxi drivers/traveller information officers/hotel customer office/the tours escort were detailed, clear, and very helpful.
	Food and beverages sold are guaranteed safe and healthy.

input variables (service quality dimension) is defined in three linguistic terms, '*High,*' '*Medium,*' and '*Low.*' Output variable (tourism destination image) is defined in five linguistic terms, '*Very High,*' '*High,*' '*Medium,*' and '*Low,*' and '*Very Low.*' Experienced travelers formulate membership function for each variable.

Following are the membership function for each variable after normalized on [0, 1] interval. A trapezoidal function approximates the membership functions (MF) for 'Low,' 'Medium,' and 'High' fuzzy set of input variables (Equation 1). $MF_i = \mu_i(x) = tz(a,b,c,d)$, where *i={L='Low', M='Medium', H='High'},* and for output variable (Equation 2) is a triangular function $MF_j = \mu_j(y) = ta(a,b,c)$, where *j={VL='Very Low', L='Low', M='Medium', H='High', VH='Very High'}.* The membership function for input variables are defined as:

$$\mu_L(x) = tz(0,0,a,b) = \begin{cases} 1 & 0 \le x < a \\ \frac{b-x}{b-a} & a \le x < b, \end{cases}$$

$$\mu_H(x) = tz(c,d,1,1) = \begin{cases} \frac{x-c}{d-c} & c \le x < d \\ 1 & d \le x \le 1 \end{cases}$$

$$\mu_M(x) = tz(a,b,c,d) = \begin{cases} \frac{x-a}{b-a} & a \le x < b \\ 1, & b \le x < c \\ \frac{d-x}{d-c} & c \le x < d \end{cases} \quad (1)$$

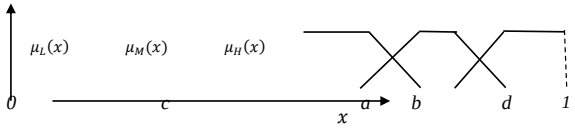

Figure 3. Membership Function for Input Variables

The membership function for output variables are defined as:

$$\mu_{VL}(x) = ta(0,0,a) = \frac{a-x}{a} \quad 0 \le x < a$$

$$\mu_L(x) = ta(0,a,b) = \begin{cases} \dfrac{x-a}{a} & 0 \le x < a \\ \dfrac{b-x}{b-a} & a \le x < b, \end{cases}$$

$$\mu_M(x) = ta(a,b,c) = \begin{cases} \dfrac{x-a}{b-a} & a \le x < b \\ \dfrac{c-x}{c-b} & b \le x \le c \end{cases}$$

$$\mu_H(x) = ta(b,c,1) = \begin{cases} \frac{x-b}{c-b} & b \le x < c \\ \frac{1-x}{1-c} & c \le x \le 1 \end{cases}$$

$$\mu_{VH}(x) = ta(c,1,1) = \frac{x-c}{1-c} \quad c \le x < 1$$

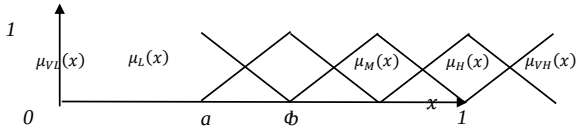

Figure 4. Membership Function for Output Variable

3.3. Fuzzy Rules Development

Fuzzy rules are developed from information conveyed by travelers after they visit an object or a tourism destination. The forms and types of information are varied according to their different experiences, knowledge, and expectations. Fuzzy rules are defined as the *IF-THEN* rules to describe system behavior. The rules are designed to describe the causality relationship among indicators of service quality dimension and tourism destination images (equation 3).

For example:

IF the direction sign for the tourism object is very clear (high) *AND* the highway infrastructure is very good (high), *AND* the tourism destination is very comfortable (high) *THEN* traveler will give a positive image of the tourism destination (very high).

In general, traveler ratings can be stated based on several dimensions of service quality, as follows:
IF a *tangible* indicator is 'fuzzy set *I*' *AND* a *reliability* indicator is 'fuzzy set *j*,' *AND* ⋯ *THEN the image of a tourism destination* is 'fuzzy set *k*.' (3)
Where fuzzy set *I, j* can be categories as '*Low.*' '*Medium,*' or '*High,*' while the fuzzy set *k* of output variable can be categories as '*Very Low*,' '*Low.*' '*Medium,*' '*High,*' or '*Very High*.'

As a simulation, in each dimension of service quality (input) uses an indicator and the tourism destination images (output) is expressed as an indicator. Table 5 shows 243 fuzzy rules that can be obtained from all possible indicators for service quality dimensión and an indicator for tourism destination image. To shorten each fuzzy set, it is used MF1=*Low*, MF2=*Medium*, and MF3=*High* for input variables (service quality dimension), and output variable (Image) MF1=*Very Low*, MF2=*Low*, MF3=*Medium*, MF4=*High*, and MF5=*Very High*.

Example of the fuzzy rule:

Rule 1: *IF* an indicator in the tangible dimension is *Low AND* an indicator in the reliability dimension is *Low*, *AND* an indicator in the responsiveness dimension is *Low*, *AND* an indicator in the assurance dimension is *Low*, *AND* an indicator in the empathy dimension is *Low THEN* the tourism destination image will be *Very Low*.

⋮

Rule 24: *IF* an indicator in the tangible dimension is *Low AND* an indicator in the reliability dimension is *Low*, *AND* an indicator in the responsiveness dimension is *High*, *AND* an indicator in the assurance dimension is *Medium*, *AND* an indicator in the empathy dimension is *High THEN* the tourism destination image will be *Medium*.

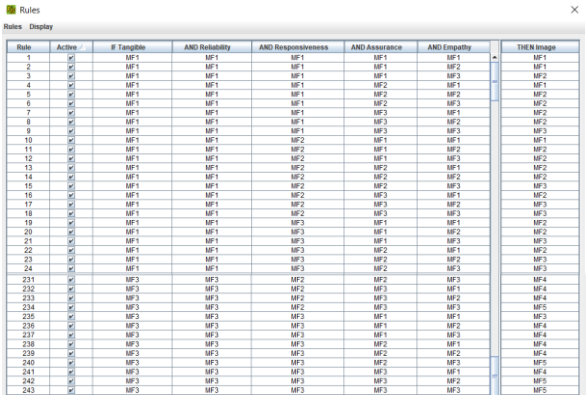

Figure 5. Fuzzy Rules of the System

3.4. Defuzzification

The inference rules set the premise to create output; then the output needs to defuzzify to obtain crisp value. Defuzzification step is needed to convert all input data into three linguistic terms (*Low*, *Medium*, or *High*) that can be used to observe the tourism destination images (*Very Low*, *Low*, *Medium*, *High*, or *Very High*). The defuzzification process transforms the fuzzy set into the crisp value that is meaningful to the decision maker. Figure 6 shows the results of inference of 243 *IF-THEN* rules. Based on the crisp value of each dimension of service quality,

fuzzification is done into a red fuzzy set according to the corresponding fuzzy set, then connected with the *AND* logic which is operationalized with the *MIN* operator.

$$\mu_{A_1}(x) \cap \mu_{A_2}(x) \cap \cdots \cap \mu_{A_n}(x) = MIN[\mu_{A_1}(x), \mu_{A_2}(x), \cdots, \mu_{A_n}(x)] \quad (4)$$

Where $A_1, A_2, \cdots, A_n$ are fuzzy set for indicators of each service quality dimension. Furthermore, the combination of all rules is operationalized with logic *OR* or *MAX*, the result is a total fuzzy set that describes the resulting image.

$$\mu_{B_1}(y) \cup \mu_{B_2}(y) \cup \cdots \cup \mu_{B_m}(y) = MAX[\mu_{B_1}(y), \mu_{B_2}(y), \cdots, \mu_{B_m}(y)] \quad (5)$$

Where $B_1, B_2, \cdots, B_m$ are fuzzy set for tourism destination image as a result of each rule.

Finally, defuzzification is performed by calculating the center point or centroid, resulting in a destination image in the form of a crisp number, i.e., a quantitative score between [0,1].

$$Centroid = \frac{\int_0^1 \mu_B(y) y dy}{\int_0^1 \mu_B(y) dy} \quad (6)$$

Figure 6 can be used as a detection and monitoring tool by decision-makers engaged in the tourism industry, to find out the image of tourism services provided, based on the quality of tourism destination services, expressed by travelers based on their experience and expectations.

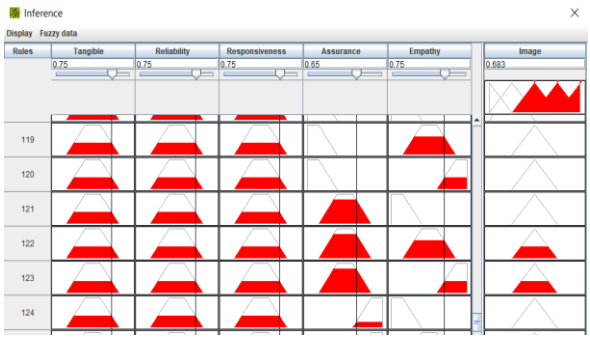

Figure 6. Inference of 243 Rules

Based on the 243 fuzzy rules above, simulation can be done to determine the impact of changes in each indicator of service quality on the image of a tourism destination. From these simulations, it will be known which indicator has a significant impact on improving the image of tourism destinations. Furthermore, changes can also be seen in 3 dimensions or 2 dimensions (Figure 7). As an example, changes in the image of tourism destinations can be observed due to changes in an indicator of tangible and reliability dimensions, when other indicators of service quality are constant. It appears that, when services on tangible and reliability dimensions increase, the image also increases.

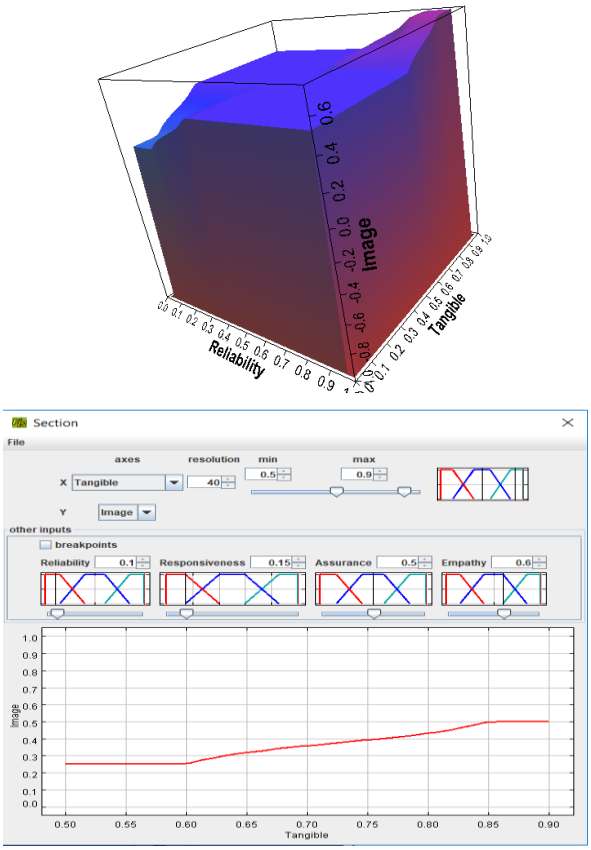

Figure 7. Visualize The Tourism Destination Image in 3D and 2D

4. Conclusion

The image of tourism destinations is essential in increasing the number of traveler visits. Increased visits have an impact on the economic growth of the tourism area. The increased tourism destination image is a strategic effort that must be carried out by tourism actors. One of the efforts to improve the image is to improve service quality. To find out the service quality that needs to be prioritized, firstly need to understand the indicators of service quality. This initial research has identified several measures/indicators that are in line with tourism destination services. In this study also produced reasoning rules to improve the image of tourism destinations based on several indicators of service quality dimensions using a fuzzy inference system. This research is still in the early stages, and there are many weaknesses, it has not yet produced reasoning rules using all possible indicators of service quality dimensions. In the future, it needs to be developed continuously the reasoning rules resulting from interviews or direct observation of a traveler or data is collected from various social media and then processed automatically with government-owned information systems, and distributed to tourism actors in real time through online media.

References

Akroush, M. N., Jraisat, L. E., Kurdieh, D. J., Al-Faouri, R. N. & Qatu, L. T. (2016). Tourism service quality and destination loyalty –the mediating role of destination image from international tourists' perspectives. Tourism Review, 71 (1), 18-44.

Bhat, M. A. (2012). Tourism Service Quality: A Dimension-specific Assessment of SERV-QUAL. Global Business Review, 13 (2), 327–337.

De Ona, J., de Ona, R., Eboli, L., & Mazzulla, G. (2016). Index numbers for monitoring transit service quality. Transportation Research Part A: Policy and Practice, 84, 18-30.

Farias, S., Aguiar, F., Kovacs, M., & Sales, F. (2013). Destination image on the web: evaluation of Pernambuco's official tourism destination web-sites. Business Management Dynamics, 2 (10), 35-48.

Hankinson, G. (2005). Destination brand images: a business tourism perspective. Journal of Services Marketing, 19 (1), 24-32.

Kim, S., Holland, S., & Han, H. (2013). A structural model for examining how destination image, perceived value, and service quality affect destination loyalty: a case study of Orlando. International Journal of Tourism Research, 15 (1), 313-328.

Mamdani E. H. & Assilian, S. (1975). An Experiment in Linguistic Synthesis with a Fuzzy Logic Controller. International Journal of Man-Machine Studies, 7, 1-13.

Parasuraman, A., Zeithaml, V. A., & Berry, L. L. (1988). SERVQUAL: a multiple-item scale for measuring consumer perceptions of service quality. Journal of Retailing, 64 (1), 12-40.

Sabri, N., Aljunid, S. A., Salim, M. S., Badlishah, R. B., Kamaruddin, R., & Malek, M. F. A. (2013). Fuzzy Inference System: Short Review and Design. International Review of Automatic Control, 6 (4), 441-449.

Said, A., Shuib, A., Ayob, N., & Yaakub, F. (2013). An evaluation of service quality from visitors' perspectives: the case of Niah National Park in Sarawak. International Journal of Business and Society, 14 (1), 61-78.

Sreekumar, Mahapatra, S., & Mahapatra, S. S. (2015). Service Quality of Indian Banks: A Fuzzy Inference System Approach, Asian Academy of Management Journal, 20 (2), 59–80.

Survey Team of Potency and Competitiveness of North Sulawesi Tourism Industry in Facing MEA (in Bahasa Indonesia edition). (2016). Tourism Industry Report, North Sulawesi Province. PSE-KP, Gadjah Mada University.

Zadeh, L. (1996). Fuzzy logic computing with words. IEEE Transactions on Fuzzy Systems, 4, 103–111.