Industrial Engineering
& Management Systems
Vol 15, No 1, March 2016, pp.77-91
ISSN 1598-7248 | EISSN 2234-6473 |
http://dx.doi.org/10.7232/iems.2016.15.1.077

Evaluating Service Quality of Korean Restaurants: A Fuzzy Analytic Hierarchy Approach

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(Received: November 18, 2015 / Revised: March 8, 2016 / Accepted: March 8, 2016)

ABSTRACT

Every service firm must find ways to attract new customers, retain existing customers, and remain competitive and profitable. As competition increases, delivering better service becomes more important. Service quality is considered as a vital aspect for the success of the firms. Restaurant cannot be separated from the service quality they have to deliver. The development of restaurant is supported with the reputation of the country where the food comes from. Recently, one of the most trending topic is Korean wave which affects the Korean cuisine. A fuzzy AHP was employed to evaluate the service quality. It is more preferable than traditional AHP which is criticized for its inability to handle the uncertainty of the decision maker's perception. Six attributes are used to evaluate five Korean restaurants in Semarang, Indonesia. The result shows that innovation is the most important attribute. It seems that decision makers viewed the food variation and new method service as main factors that the restaurants have to manage. This finding can provide the managers with valuable insights into the attribute that reflects customers' perceptions; also to position their service based on their competitors. Validating the scale in other culture-based restaurants is an interesting area to be pursued.

Keywords: Customer Satisfaction, Fuzzy AHP, Korean Restaurants, Service Quality

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1. INTRODUCTION

Service sector in today's highly competitive global market has grown fast and constantly attempts to look for continuous improvement. This development is corroborated by a shift of employment from manufacturing sector to service sector. Data from World Bank shows that in most of the developed countries, such as the United States, Germany, France, and Japan, more than 70% of the labor force is engaged in the service sector (World Bank, 2015). The phenomenon can be considered as a signal of being mature and high quality of standard of living. As consequences, the service providers require both to have a sensitivity for any changes that can have an effect on the sustainability of their businesses and to put a concern in a customer satisfaction as their primary goals (Kotler, 2003).

The quality of the service which has to deliver to the customers has been considered as a critical factor for the success of the service provider due to its close connection with customer satisfaction (Chow *et al*., 2007; Gilbert and Veloutsou, 2006; Parasuraman *et al*., 1985). Additionally, excellent service precedes customer retention and leads to repeat customer purchase behavior (Cronin and Taylor, 1992; Ladhari *et al.*, 2008) which can eventually increase the market share of service pro-

viders as well as generates high incomes (Luo and Homburg, 2007). By the meaning, the qualities of the services should be measured.

Evaluating service quality is challenging since the nature of the service is intangible, simultaneous, and heterogeneous. In addition to the need of measuring the service quality, it is essential to apply an effective tool for recognizing and prioritizing relevant attributes to develop a systematic service quality measurement process. This method also should develop consensus decision making. Therefore, the multi-criteria decision making (MCDM) theory could be applied in analyzing the performance of service quality of some alternatives. This MCDM theory is a discipline that take aim at supporting decision makers who are faced with formulating various and conflicting evaluations.

Analytic hierarch process (AHP) proposed by Saaty (1980) is one of the most popular and powerful MCDM tool for decision making that has been used for years. Despite of the advantages as seeking consistency in judgments, being user friendly, allowing users to structure complex problems in the form of a hierarchy levels, and relatively easy to handle multiple attributes, AHP has been criticized for its inability to adequately handle the ambiguity of the concepts that are associated with human being's subjective judgment. Human's judgments in AHP are represented as precise; yet in real life situations, the linguistic assessment of human feelings and perceptions are fuzzy. Hence, it is not reasonable to represent it in terms of precise numbers-it is more convenience to give interval judgments than fixed value judgments.

In this study, it is believed that service quality evaluation resulted from evaluators can be considered as linguistic variables. Thus, it must be conducted in an uncertain, fuzzy environment. The fuzzy set theory by Zadeh (1965) is considered to have capability to handle this situation. It is designed to model the vagueness of human cognitive processes and provide formalized tool for dealing with the imprecision intrinsic to many problems. This fuzzy set theory has been combined with AHP to present the fuzzy AHP. It can provide the flexibility and robustness needed for the decision maker to understand the decision problem. The fuzzy AHP has been applied in many fields of management science, such as decision making (e.g. Calabrese *et al.*, 2013; Ho *et al*., 2012; Huang *et al.*, 2008) and also in service quality area (e.g. Bilsel *et al.*, 2006; Büyüközkan *et al.*, 2011; Büyüközkan and Çifçi, 2012). However, it is barely employed in restaurants.

Likewise, restaurant as a part of food service business also cannot be detached from the service quality they have to deliver to the customers. It has been challenged to create a unique and clear distinction among its competitors along with its quality of the service to be success in differentiating its service. This study aims to apply the fuzzy AHP approach in Korean restaurants located in Semarang, Indonesia. Korean restaurants have been chosen since Korean cuisine is considered emerging, indicating tremendous potential for growth period, as well as being perceived differently for its uniqueness and flavor (Jang *et al*., 2009). These attributes could attract Indonesian customers who want to experience a new taste of food. Previous study of foreign travelers in South Korea that talks about the possibility of globalization of Korean cuisine found that a vegetable-based healthy diet is the most vital factor that will qualify Korean cuisine to go global (Hong *et al*., 2009). This study also develops a new multiple-item scale for evaluating service quality of restaurants, especially for Korean restaurants which have distinctive characteristics among other ethnic or culture-based restaurants. It may provide some insights to the managers of the restaurants on how patrons rate the service quality; hence enabling the managers to position their service quality based on their competitors and to discover dimensions of service which they have to improve.

The paper is structured as follows. In the following sections, the research design of this study is introduced as well as the attributes that are used in this study. Next, the fuzzy AHP approach is presented to give the readers such understanding about the tools that is used in this study. A case study and discussion to exhibit the applicability of the method is reported in the fourth section. Finally, the conclusion and future research direction will be presented in the last section.

2. RESEARCH DESIGN

In this study, the attributes for evaluating service quality of Korean restaurants were determined as six attributes: tangibles, responsiveness, empathy, assurance, reliability, and innovation (Chin and Tsai, 2013). The five first attributes was the dimensions of classic SERVQUAL and the last was added due to a consideration that it had a positive influence on customer satisfaction by the mediating effects of service quality (Tsai *et al.*, 2010). The sub-attributes used in this study are based on research by Chin and Tsai (2013). However, the sub-attributes had been slightly modified since this study was conducted in Korean restaurants.

Tangibles (T) refers to restaurant's facilities-equipment, physical design (exterior and interior design, tableware), environment, appearance of the employees, and cleanliness. The availability of restaurant's equipment, such as plates, spoons, and chopsticks when the restaurant is full of customers, is critical to provide a satisfactory service. It is important for restaurant to be convenient; hence, the menu which is offered should clarify the customers to provide easiness. The waitperson's appearance also plays an important role in providing the valuable service to the customers. A favorable scenario under this facet would be "The waitperson serving you is clean and neat" (Luoh and Tsaur, 2007). The cleanliness of the restaurants is one of the issues that

should be evaluated in the quality of service since the human health plays as the main objective. Since the customers do not take delivery of only meals and beverages, but also large component of services, they undoubtedly depend on other cues in the absence of tangibles evidence by which to assess the service quality. Sub-attributes for tangibles includes: (1) creating attractive Korean environment (T1), (2) showing appearance of Korean nuance (T2), (3) keeping cleanliness of tableware and dining environment (T3), (4) offering clear and legible menu (T4), and (5) creating pleasant dining atmosphere (T5).

Responsiveness (R) can be defined as a consciousness of the employees, chefs, and manager when delivering or serving the food to the customers. It also relates with the aspect of how far the restaurant could resolve a problem about customers' concerns and manage complaints that customers suggested. The quality of the service may be enhanced if, for example, employees have knowledge about the meals which are being served, or if employees respond enthusiastically to a customer's request for service. The employees also must have a willingness whenever help is needed, listening the customers complaints and come up with solutions through the needs of customers. In sum, its sub-attributes are: (1) providing enthusiastic service (RES1), (2) possessing Korean cuisine knowledge (RES2), (3) showing ability to deal with emergencies (RES3), and (4) providing activity information actively (RES4).

Empathy (E), as a third attribute, means caring and considering personally to customers. Caring means individualized customer service and attention to customers and focus on understanding needs of customers, perhaps by adhering to special dietary requirements, or being sympathetic towards customers' problems (Lee and Hing, 1995). This attribute includes: (1) displaying positive concern for individual customers (E1), (2) providing meticulous service (E2), (3) having flexible rules with customers (E3), and (4) considering customers' requests in advance (E4).

Assurance (A) can be described as employee's experience, attitude, and ability to bring the trust and belief. The customers should be able to believe in the recommendations of employee, feel confident that food is free from contamination and be able to say any concern without fear. Because customers feel dependent to service providers psychologically, courtesy of the employee is important for the confidence of the customers. Communication, such as the transfer of information between employee and customers, the degree of interaction, and the level of two-way communication, is critical in assurance attribute. Communication manner, the attitude of employee in the service setting communicated with a customer is also a common point of discussions. Sub-attributes belong to this attribute are: (1) displaying good communication manners (A1), (2) having well-trained employees (A2), (3) exhibiting capability of answering customer's questions (A3), and (4) offering customers a sense of security (A4).

Reliability (L) means ability to give reliable and accurate offer that had been given. Accuracy presents information about service, such as the menu and bills, in a clear and concise way. It also may involve reservations of tables, adherence to customer requests regarding the preparation of menu items and accurate billing (Lee and Hing, 1995). Reliable employee is the one who always get the menu correctly based on customers' orders. Its includes: (1) delivering guaranteed and timely service (REL1), (2) presenting correct bills (REL2), (3) maintaining and cleaning the environment and facilities regularly (REL3), and (4) serving tasty food that meets customers' demand (REL4).

Finally, innovation (I) can be considered as what restaurant can give to customers in case of food variation and new method of service. The food variation relates with taste, aesthetic, appearance, and price. The new method refers to the way of employee delivering the menu and the way of manager offering special promotion to the customers. The sub-attributes are: (1) offering innovative menu (I1), (2) providing customized services (I2), and (3) offering innovative activities (I3).

The objective of this research is set to find out the best service quality performance of Korean restaurant in Semarang, Indonesia. Seoul Palace, Kobe Garden, Chung Gi Wa, Dae Jang Geum, and Gang Gang Sullai are selected because they are the leader in the field of providing Korean cuisine in Semarang and also have great reputations. Seoul Palace which was founded 24 years ago is the first Korean restaurant in Semarang and well known as one of the best Korean cuisine providers in this area. In order to make the taste alike with the original dish, the owner even did a research prior to the country of origin before opening the restaurant. It is easy to find the restaurant since it is located in the center of the city. Kobe Garden was founded in 1998 by Semarang native family and located on Bukit Raya Street, in the heart of a populated upper-middle-class neighborhood. The concept was simply to create a cozy environment that was well suited to have a great gathering. The restaurant uses organic rice to serve the customers since it is concerned with health, in which Korean food is known for its healthy food. Chung Gi Wa is the youngest Korean restaurant among others, which is founded on August 2014. First established in Jakarta, the capital city of Indonesia, the restaurant offers the most various barbecue menu in wood-made interior design. Dae Jang Geum is located in the luxurious neighborhood, along with fancy restaurants and five stars hotels. The nuance of Korea of the interior design makes the customers believe that they are in the actual Korean restaurant. Gang Gang Sullai offers all-you-can-eat meals so that customers only pay uniform bills.

In order to apply the fuzzy AHP methodology to the prioritizing of attributes for assessing the service quality of Korean restaurants, the attributes abovementioned are initially structured into different hierarchy levels. The hierarchy of the decision model is shown in

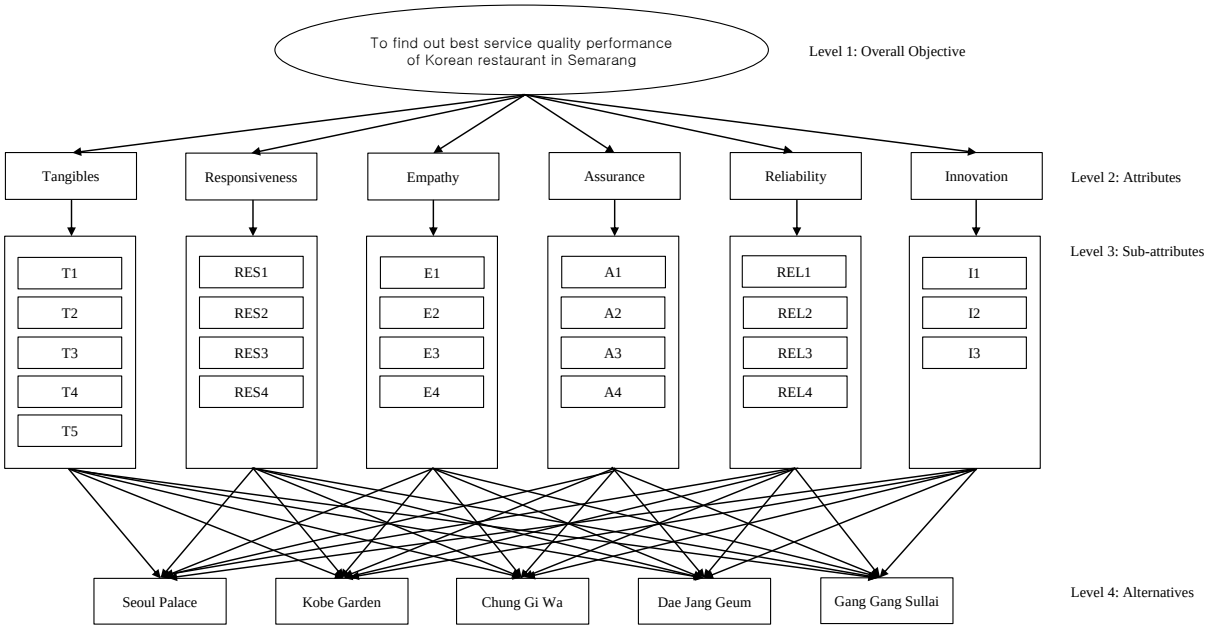

Figure 1. The evaluation framework of the Korean restaurants service quality model.

Figure 1, where the goal is to find out the best service quality performance of Korean restaurant in Semarang. This hierarchy of attributes is the subject of a pairwise comparison of the fuzzy AHP. Data are collected from five experts who are very fond of Korean cuisine and have abundant experiences in visiting Korean restaurants in Semarang. The decision makers are asked to compare the elements, i.e. sub-attributes, on a pairwise basis in order to estimate their relative importance in relation to the element at the immediately preceding level, i.e. the attributes. A nine-point scale questionnaire which is attached in Appendix, is used to show the decision makers' judgment between options as equally, moderately, strongly, very strongly, and extremely favorable (or unfavorable). The theory of fuzzy AHP that is used in this study is briefly described in the following section.

3. FUZZY AHP

This study employed the fuzzy AHP approach to evaluate the service quality of Korean restaurants. To be simple, the fuzzy AHP approach extends the AHP by Saaty (1980) by combining it with the fuzzy set theory by Zadeh (1965). AHP is primarily applied in decision-making problems with multiple attributes, usually conflicting, and with uncertain results. Basically, decision makers have to decompose the goal of the decision process into its attributes (and sub-attributes if any) and alternatives, in ordered hierarchy. Once the hierarchy has been structured, the decision makers evaluate the importance of each attribute in pairwise comparisons, structured in matrices. The final scoring is on a relative basis, comparing the importance of one decision alternative to another. AHP also offers a mechanism for checking the consistency of the evaluations made by the decision makers. The information and priority weights of elements can be obtained using direct questioning or a questionnaire method. AHP is very popular has been used in solving many MCDM problems due to its numerous advantages. Several researches that used AHP are attributed here: Badri (2001), Chan and Chan (2004), Hou and Su (2007), Lee and Kozar (2006), Liu and Hai (2007).

Regardless of its some advantages, AHP has been critiqued for some reasons. It does not completely capture the importance of qualitative aspects because its discrete scale cannot reflect the human thinking style. In AHP, human's judgments are represented as precise number, however, when the preferences of the decision makers are affected by uncertainty and imprecision, it is not reasonable to use definite and precise numbers to represent linguistic judgments (Chan and Kumar, 2007; Kwong and Bai, 2003). In order to deal with ambiguity, the fuzzy logic (Zadeh, 1965) is integrated into AHP to give rise to the fuzzy AHP approach.

Fuzzy set theory is designed to model the human cognitive processes' imprecision or vagueness. The key idea is that an element has a degree of membership in a fuzzy set (Zimmermann, 2001). It has the advantage of represent vagueness and provide formalized tools for dealing with the imprecision intrinsic to many problems. Fuzzy AHP converts linguistic judgments in triangular fuzzy numbers (TFNs) in fuzzy pairwise comparison matrices. These matrices are then processed to obtain the relative weights of attributes and the ranking of such alternatives. Several theoretical results have been presented as the application of fuzzy set theory in AHP, see

for example: Bilsel *et al.* (2006), Büyüközkan *et al.* (2011), Büyüközkan and Çifçi (2012), Chamodrakas *et al.* (2010), Calabrese *et al.* (2013), Dura'n and Aguilo (2008), Ho *et al.* (2012), Huang *et al.* (2008), Hsu *et al.* (2007), Kang and Lee (2007), Liu and Lai (2009).

There are various fuzzy AHP methods proposed by numerous authors to handle the comparison matrices (Buckley, 1985; Chang, 1996; Custora and Buckley, 2001; Lee, 2010; Wang and Chin, 2006). Among them, Chang's method (1996) is widely used, also in this study, due to its implementation simplicity to calculate relative weights.

3.1 Triangular Fuzzy Numbers

Definition 1. Let $M \in F(R)$ be called a fuzzy number if exists $x_0 \in R$ such that $\mu_M(x_0)=1$; and for any $\alpha \in [0, 1]$, $A_\alpha = \lfloor x, \mu_{A_\alpha}(x) \geq a \rfloor$ is a closed interval. $F(R)$ is represented all fuzzy number sets and R is the set of real numbers.

Definition 2. A triangular fuzzy number is denoted as $M = (l, m, u)$ if its membership function $\mu_M(x): R \to [0, 1]$ is equal to:

$$\mu_M(x)=\begin{cases}\dfrac{x}{m-l}-\dfrac{l}{m-l}, & x\in[l, m],\\ \dfrac{x}{m-u}-\dfrac{u}{m-u}, & x\in[m, u],\\ 0, & \text{otherwise,}\end{cases} \quad (1)$$

where $l \leq m \leq u$, l and u are lower and upper value of the support of M respectively, as well as m is the mid-value of M. The support of M is the set of elements $\{x \in R \mid l < x < u\}$. Therefore, when $l = m = u$, it is a non-fuzzy number by convention. In this study, first linguistic terms are used to represent the decision makers' assessments, and then triangular fuzzy numbers are used for evaluations, which are shown in Table 1.

Let two triangular fuzzy numbers M_1 and M_2 where $M_1 = (l_1, m_1, u_1)$ and $M_2 = (l_2, m_2, u_2)$, the main operational laws are as follows (Chang, 1996):

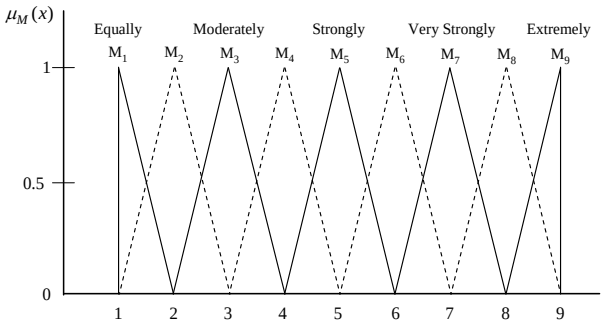

Figure 2. The membership functions of the triangular numbers.

1. $(l_1, m_1, u_1) \oplus (l_2, m_2, u_2) = (l_1 + l_2, m_1 + m_2, u_1 + u_2)$. (2)
2. $(l_1, m_1, u_1) \otimes (l_2, m_2, u_2) \approx (l_1 l_2, m_1 m_2, u_1 u_2)$. (3)
3. $(\lambda, \lambda, \lambda) \otimes (l_1, m_1, u_1) = (\lambda l_1, \lambda m_1, \lambda u_1)$, $\lambda > 0$, $\lambda \in R$. (4)
4. $(l_1, m_1, u_1)^{-1} \approx (1/u_1, 1/m_1, 1/l_1)$. (5)

3.2 Fuzzy Representation of an Assessment in a Pairwise Comparison

Let triangular numbers M_1, M_3, M_5, M_7, and M_9 are used to represent the assessment from "equally" to "extremely preferred"; and M_2, M_4, M_6, and M_8 are as the middle values. Figure 2 shows the membership functions of the triangular fuzzy numbers $M_t = (l_t, m_t, u_t)$ where t = 1, 2, ⋯, 9 and where l_t, m_t, and u_t are the lower, middle, and upper values of the fuzzy number M_t respectively. δ represents a fuzzy degree of judgment where $u_t - l_t = l_t - u_t = \delta$. A larger value of δ implies a higher fuzzy degree of judgment. When δ = 0, the judgment is a non-fuzzy number. Zhu *et al.* (1999) showed that δ should be larger than or equal to one-half. In this study, the value δ was set to be one.

3.3 Value of Fuzzy Synthetic Extent

Let $X = \{x_1, x_2, \cdots, x_n\}$ be an object set and $U = \{u_1, u_2, \cdots, u_n\}$ be a goal set. Based on the extent analy-

Table 1. Triangular fuzzy numbers scale

Linguistic	Triangular Fuzzy Number	Reciprocal
Same comparison (equal)	(1, 1, 1)	(1, 1, 1)
Midline (intermediate)	(1/2, 1, 3/2)	(2/3, 1, 2)
One element is important enough than others (moderately)	(1, 3/2, 2)	(1/2, 2/3 ,1)
Midline (intermediate)	(3/2, 2, 5/2)	(2/5, 1/2, 2/3)
One element is strong enough than other (strongly)	(2, 5/2, 3)	(1/3, 2/5, 1/2)
Midline (intermediate)	(5/2, 3, 7/2)	(2/7, 1/3, 2/5)
One element is stronger on important aspect than other (very strongly)	(3, 7/2, 4)	(1/4, 2/7, 1/3)
Midline (intermediate)	(7/2, 4, 9/2)	(2/9, 1/4, 2/7)
One element is absolute stronger than other (extremely strong)	(4, 9/2, 9/2)	(2/9, 2/9, 1/4)

sis method, each object could be taken to perform extent analysis for each goal respectively. Then the m extent analysis values for each object can be found with the following signs:

$$M_{g_i}^1, M_{g_i}^2, \cdots, M_{g_i}^m, \quad I = 1, 2, \cdots, n, \tag{6}$$

where $M_{g_i}^j = \left(l_{g_i}^j, m_{g_i}^j, u_{g_i}^j\right)$, $j = 1, 2, \cdots, m$ are triangular fuzzy numbers.

Definition 3. Let $M_{g_i}^1, M_{g_i}^2, \cdots, M_{g_i}^n$ be the values of extent analysis of i-th object for m goals, then the value of fuzzy synthetic extent with respect to the i-th object is defined as (Chang, 1996):

$$S_i = \sum_{j=1}^{m} M_{g_i}^j \otimes \left[\sum_{i=1}^{n}\sum_{j=1}^{m} M_{g_i}^j\right]^{-1} \tag{7}$$

3.4 Weight Vector

In order to obtain the estimates for the vectors of weights under each attribute, a principle of comparison for fuzzy numbers has to be taken into consideration.

Definition 4. Let M_1 and M_2 are two triangular fuzzy numbers that are denoted by (l_1, m_1, u_1) and (l_2, m_2, u_2) respectively, then the degree of possibility of $M_1 \geq M_2$ is defined as

$$V(M_1 \geq M_2) = \sup_{x \geq y}\left[\min\left(\mu_{M_1}(x), \mu_{M2}(y)\right)\right] \tag{8}$$

When a pair (x, y) exists such that $x \geq y$ and $\mu_{M_1}(x) = \mu_{M_2}(y) = 1$, then:

$$V(M_1 \geq M_2) = 1, \text{ iff } m_1 \geq m_2. \tag{9}$$

If $m_1 \leq m_2$, let $V(M_1 \geq M_2) = \text{hgt}(M_1 \cap M_2)$. Then

$$V(M_1 \geq M_2) = \mu(d) = \begin{cases} \dfrac{l_2 - u_1}{(m_1 - u_1) - (m_2 - l_2)}, & l_2 \leq u_1, \\ 0, & \text{otherwise}, \end{cases} \tag{10}$$

Where d is the abscissa of the highest intersection point D between M_1 and M_2 (see Figure 3).

Definition 5. The degree of possibility for a fuzzy number to be greater than k fuzzy numbers M_i (i = 1, 2, $\cdots$, k) can be defined as

$$V(M \geq M_1, M_2, \cdots, M_k) = \min V(M \geq M_i). \tag{11}$$

Assume that

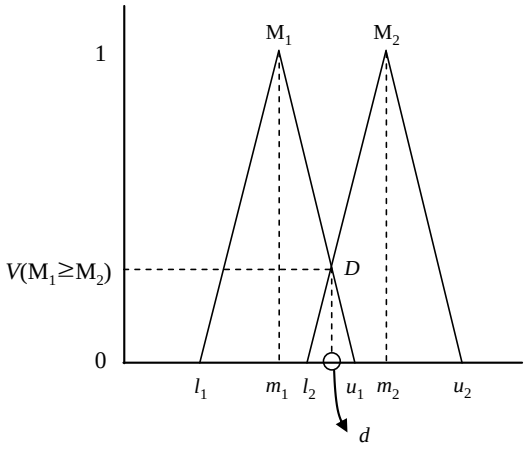

Figure 3. Interpretation of the location of d.

$$d'(A_i) = \min V(S_i \geq S_k), \tag{12}$$

where A_i is the i-th element of the k-th level for k = 1, 2, $\cdots$, n; $k \neq i$. The number of elements in the k-th level is n. Then the weight vector of the k-th level is obtained as follows:

$$W' = (d`(A_1), d`(A_2), \cdots, d`(A_n))^T. \tag{13}$$

After normalization, the normalized weight vector is

$$W = (d(A_1), d(A_2), \cdots, d(A_n))^T, \tag{14}$$

where W is non-fuzzy number.

4. CASE STUDY

4.1 Step-by-S tep

The following is the application of fuzzy AHP to evaluate the service quality of Korean restaurants in Semarang. The fuzzy AHP approach was employed to choose the best Korean restaurants based on the aforementioned attributes. First, the decision makers filled the pairwise comparison to express their preferences between the alternatives, attributes, and sub-attributes in a nine-point scale questionnaire. Their answers were then transformed into triangular fuzzy numbers. If a decision maker consider that attribute i is moderately important as compared with the attribute j, then the triangular fuzzy number used is (1, 3/2, 2). On the other hand, if attribute j is believed to be less moderately important than attribute i, the pairwise comparison between j and I could be presented by using its reciprocal: (1/2, 2/3, 1). To be simple, the example of the fuzzy number of the pairwise comparison for "innovation" attribute to select the best sub-attributes is given in Table 2. A fuzzy judgment matrix for this comparison is given as follows:

Table 2. Example of pairwise comparison for "innovation" attribute

Sub- attributes	I1	I2	I3
I1	(1, 1, 1)	(1.5, 2, 2.5) (2.5, 3, 3.5) (0.4, 0.5, 0.67) (1.5, 2, 2.5) (3.5, 4. 4,5)	(1.5, 2, 2.5) (1, 1, 1) (1, 1, 1) (1.5, 2, 2.5) (3.5, 4, 4.5)
I2	(0.4, 0.5, 0.67) (0.29, 0.33, 0.4) (1.5, 2, 2.5) (0.4, 0.5, 0.67) (0.22, 0.25, 0.29)	(1, 1, 1)	(0.5, 1, 1.5) (0.4, 0.5, 0.67) (0.4, 0.5, 0.67) (0.67, 1, 1.5) (0.22, 0.25, 0.29)
I3	(0.4, 0.5, 0.67) (1, 1, 1) (1, 1, 1) (0.4, 0.5, 0.67) (0.22, 0.25, 0.29)	(0.67, 1, 2) (1.5, 2, 2.5) (1.5, 2, 2.5) (0.67, 1, 1.5) (3.5, 4, 4.5)	(1, 1, 1)

$$I = \begin{array}{c} \\ \text{I1} \\ \text{I2} \\ \text{I3} \end{array} \begin{array}{c} \begin{array}{ccc} \text{I1} & \text{I2} & \text{I3} \end{array} \\ \begin{bmatrix} (1,1,1) & (0.4,2.3,4.5) & (1,2,4.5) \\ (0.22,0.72,2.5) & (1,1,1) & (0.22,0.65,1.5) \\ (0.22,0.65,1) & (0.67,2,4.5) & (1,1,1) \end{bmatrix} \end{array}.$$

The values of each entry of matrix I can be obtained by (Chen, 2004):

$$I_{ij} = \left[\min\left(l_{g_i}^j\right), \text{average}\left(m_{g_i}^j\right), \max\left(u_{g_i}^j\right)\right].$$

The value of fuzzy synthetic extent can be obtained using Eq. (7). For "innovation" attribute, the values of fuzzy synthetic extent can be obtained as follows:

$$S_{\text{I1}} = (2.4, 5.3, 10) \otimes \left(\frac{1}{21.50}, \frac{1}{11.32}, \frac{1}{5.73}\right) = (0.112, 0.468, 0.1745),$$

$$S_{\text{I2}} = (1.44, 2.37, 5) \otimes \left(\frac{1}{21.50}, \frac{1}{11.32}, \frac{1}{5.73}\right) = (0.067, 0.209, 0.873),$$

$$S_{\text{I3}} = (1.89, 3.65, 6.5) \otimes \left(\frac{1}{21.50}, \frac{1}{11.32}, \frac{1}{5.73}\right) = (0.088, 0.323, 1.134).$$

To obtain the vector of weight, Eq. (9) and Eq. (10) are used. The calculation of weight vector for "innovation" attribute is given as follows:

$$V(\text{S}_{\text{I1}} \geq \text{S}_{\text{I2}}) = 1,$$
$$V(\text{S}_{\text{I1}} \geq \text{S}_{\text{I3}}) = 1,$$
$$V(\text{S}_{\text{I2}} \geq \text{S}_{\text{I3}}) = \frac{0.088 - 0.873}{(0.209 - 0.873) - (0.323 - 0.088)} = 0.874,$$
$$V(\text{S}_{\text{I2}} \geq \text{S}_{\text{I1}}) = \frac{0.112 - 0.873}{(0.209 - 0.873) - (0.468 - 0.112)} = 0.746,$$
$$V(\text{S}_{\text{I3}} \geq \text{S}_{\text{I1}}) = \frac{0.112 - 1.134}{(0.323 - 1.134) - (0.468 - 0.112)} = 0.875,$$
$$V(\text{S}_{\text{I3}} \geq \text{S}_{\text{I2}}) = 1.$$

Finally, by using Eq. (12) the normalized weight vector can be found. The step for obtaining the normalized weight vector for "innovation" attribute is given as follows:

$d'(\text{I1}) = \min V(S_{\text{I1}} \geq S_{\text{I2}}, S_{\text{I3}}) = \min(1, 1) = 1,$
$d'(\text{I2}) = \min V(S_{\text{I2}} \geq S_{\text{I1}}, S_{\text{I3}}) = \min(0.746, 0.874) = 0.746,$
$d'(\text{I3}) = \min V(S_{\text{I3}} \geq S_{\text{I1}}, S_{\text{I2}}) = \min(0.875, 1) = 0.875.$

Therefore, $W^{\wedge} = (1, 0.746, 0.875)^{\text{T}}$. By normalization, the normalized weight vector for "innovation" attribute with respect to the sub-attributes I1, I2, I3 is: $W = (0.382, 0.285, 0.334)^{\text{T}}$.

4.2 Result

The previous calculation was repeated for all attributes and also for comparing the alternatives, i.e. the Korean restaurants in Semarang, with respect to the attributes. The final results of application of fuzzy AHP in evaluating the service quality of Korean restaurants in Semarang are alternative priority weights indicated the important of attributes of service quality and the alternatives' priority referred to each attribute. The results can be seen in Table 3 and 4.

The weights for each attribute are tangibles with 0.163, responsiveness with 0.159, empathy with 0.165, assurance with 0.171, reliability with 0.168, and innovation with 0.175. This seems that the decision makers viewed the food variation and new method for delivering service to the customer as the main factors that the

restaurants have to manage to win a competition among their competitors. Afterwards, employee's experience, attitude, and ability to bring the trust to the customers is less important and next is giving reliable and accurate offer to the customers. Restaurant's physical appearance, equipment, and cleanliness is considered less important than caring or individualized customer service. The least important attribute in evaluating the service quality of Korean restaurants is responsiveness, which is the consciousness of the restaurants' employee and manager when delivering the service to the customers.

As can be seen from Table 3, the weights for sub-

Table 3. Summary of alternative priority weights for each attribute

Tangibles	T1	T2	T3	T4	T5	Alternative Priority Weight
Weight	0.192	0.197	0.219	0.193	0.199	
Seoul Palace	0.203	0.219	0.210	0.208	0.209	0.210
Kobe Garden	0.147	0.163	0.159	0.155	0.184	0.162
Chung Gi Wa	0.237	0.224	0.228	0.219	0.214	0.224
Dae Jang Geum	0.177	0.181	0.203	0.206	0.187	0.191
Gang Gang Sullai	0.235	0.212	0.200	0.211	0.206	0.212
Responsiveness	RES1	RES2	RES3	RES4		Alternative Priority Weight
Weight	0.307	0.274	0.186	0.233		
Seoul Palace	0.217	0.207	0.209	0.231		0.216
Kobe Garden	0.168	0.179	0.177	0.166		0.172
Chung Gi Wa	0.219	0.212	0.217	0.216		0.216
Dae Jang Geum	0.195	0.192	0.193	0.190		0.193
Gang Gang Sullai	0.201	0.209	0.205	0.197		0.203
Empathy	E1	E2	E3	E4		Alternative Priority Weight
Weight	0.289	0.261	0.263	0.186		
Seoul Palace	0.204	0.210	0.201	0.204		0.204
Kobe Garden	0.181	0.182	0.183	0.180		0.182
Chung Gi Wa	0.219	0.214	0.214	0.228		0.218
Dae Jang Geum	0.195	0.189	0.193	0.178		0.189
Gang Gang Sullai	0.202	0.205	0.208	0.210		0.206
Assurance	A1	A2	A3	A4		Alternative Priority Weight
Weight	0.263	0.323	0.037	0.376		
Seoul Palace	0.204	0.187	0.203	0.185		0.191
Kobe Garden	0.177	0.195	0.179	0.192		0.188
Chung Gi Wa	0.213	0.215	0.213	0.225		0.218
Dae Jang Geum	0.201	0.199	0.194	0.192		0.197
Gang Gang Sullai	0.205	0.205	0.211	0.206		0.205
Reliability	REL1	REL2	REL3	REL4		Alternative Priority Weight
Weight	0.293	0.233	0.257	0.216		
Seoul Palace	0.191	0.207	0.187	0.211		0.198
Kobe Garden	0.184	0.194	0.193	0.180		0.188
Chung Gi Wa	0.213	0.211	0.203	0.231		0.214
Dae Jang Geum	0.199	0.194	0.207	0.181		0.196
Gang Gang Sullai	0.214	0.194	0.210	0.196		0.204
Innovation	I1	I2	I3			Alternative Priority Weight
Weight	0.382	0.285	0.334			
Seoul Palace	0.201	0.208	0.202			0.203
Kobe Garden	0.192	0.172	0.180			0.183
Chung GiWa	0.203	0.218	0.210			0.210
Dae Jang Geum	0.202	0.196	0.197			0.199
Gang Gang Sullai	0.203	0.206	0.210			0.206

attribute of tangibles attribute are given as follows. Keeping cleanliness of tableware and dining environment is believed to be the most important with the weight of 21.9%. The next is creating pleasant dining atmosphere with 19.9%, showing appearance of Korean nuance with 19.7%, and offering clear and legible menu with 19.3%. Creating attractive Korean environment is believed by the decision makers to be the least important sub-attribute of tangibles attribute with 19.2%. The Korean restaurant with the best service quality performance on tangibles attribute is Chung Gi Wa. In responsiveness attribute, providing enthusiastic service is considered as the most important sub-attribute with weight of 30.7%. The next is possessing Korean cuisine knowledge with 27.4%, providing activity information actively with 23.3%, and the last is showing ability to deal with emergencies with 18.6%. Seoul Palace and Chung Gi Wa are considered to be the best Korean restaurant in accordance with responsiveness attribute by 21.6%. In the third attribute, empathy, the sub-attribute which is thought to be the most important is displaying positive concern for individual customers with weight of 28.9%. Having flexible rules with customers and providing meticulous service are believed to be the second and third most important with weight of 26.3% and 26.1% respectively. In assurance attribute, offering customers a sense of security is considered the most important with weight of 37.6%. The next is having well-trained employees with weight of 32.3% and displaying good communication manners with weight of 26.3%. The least important sub-attribute is exhibiting capability of answering customer's questions with weight of 3.7%. The decision makers chose Chung Gi Wa to be the best Korean restaurant in performing assurance attribute. Delivering guaranteed and timely service is the best sub-attribute in reliability attribute with weight of 29.3%. Maintaining and cleaning the environment and facilities regularly is the second most important with 25.7% and presenting correct bills is the third with weight of 23.3%. The least important sub- attribute in reliability attribute is serving tasty food that meets customers' demand with weight of 21.6%. Chung Gi Wa is the best Korean restaurant in performing reliability attribute with 21.4% among others. The last attribute is innovation, where the most important sub-attribute is offering innovative menu with weight of 38.2%. Offering innovative activities has weight of 33.4% and the least important is providing customized services with weight of 28.5%. For this attribute, Chung Gi Wa is considered to be the best Korean restaurant.

Finally, the Korean restaurants also were compared using fuzzy AHP. According to all the calculations, Chung Gi Wa is considered as the best restaurant with weight of 0.217. The next is Gang Gang Sullai with 0.206, Seoul Palace with 0.204, and Dae Jang Geum with 0.194. The restaurant which is regard as the worst Korean restaurant in performance is Kobe Garden with 0.179.

4.3 Consistency Checking

Saaty (1980) proposed using consistency index (*CI*) and consistency ratio (*CR*) to verify the consistency of the comparison matrix. CI and CR are defined as follows:

$$CI = (\lambda_{max}\text{-}n)/(n\text{-}1), \quad (15)$$
$$CR = CI/RI, \quad (16)$$

where n is the number of decision makers and RI represents the average consistency index over numerous random entries of same order reciprocal matrices. If $CR \leq 0.1$, the estimate is accepted: indicating consistency; otherwise, new comparison matrices are solicited until $CR \leq 0.1$.The results of the consistency test and the CR of the comparison matrices from case study above are all less than 0.1, indicating "consistency." Furthermore, the CR of the aggregate matrix is 0.005, also less than 0.1, indicating "consistency" as well.

4.4 Sensitivity Analysis

After the weights of all attributes were obtained (given in Table 4), sensitivity analysis was performed to explore the response of the overall priority of alternatives to changes in the relative value of each attribute. Small changes in the weights can significantly affect the final ranking; hence, the stability of the ranking must be tested using sensitivity analysis. It can be performed using different scenarios that reflect alternative future developments or different views regarding the importance of the attributes. Sensitivity analysis is neces-

Table 4. Final ranking of service quality performance of Korean restaurants

	Tangibles	Responsiveness	Empathy	Assurance	Reliability	Innovation	Alternative priority weight
Weight	0.163	0.159	0.165	0.171	0.168	0.175	
Seoul Palace	0.210	0.216	0.198	0.191	0.204	0.203	0.204
Kobe Garden	0.162	0.172	0.188	0.188	0.182	0.183	0.179
Chung Gi Wa	0.224	0.216	0.214	0.218	0.218	0.210	0.217
Dae Jang Geum	0.191	0.193	0.196	0.197	0.189	0.199	0.194
Gang Gang Sullai	0.212	0.203	0.204	0.205	0.206	0.206	0.206

sary because changing the importance of attribute requires various levels of six different attributes with respect to evaluating the synthesis value of the five Korean restaurants. Decreasing or increasing the weights of each attribute can view the resulting changes in the weights of the alternatives and their rankings. If the ranking is highly sensitive to small changes in the weights of the attributes, careful analysis must be presented. The weights of the attribute were adjusted separately, simulating the weights between 0% and 100%. However, the weights of other attributes also alter accordingly, subject to the total weights of 100%.

The performance graph that is depicted in Figure 4 shows how the Korean restaurants perform with respect to the change in scenario for various parameters. Performance sensitivity of alternatives is analyzed when all attributes are increased from their current level by 10%, 25%, and 50%. Increasing tangibles (T) by 10% increases the global weight of Kobe Garden decreases from 0.179 to 0.086. Moreover, increasing T by 25% would decrease the weight of Kobe Garden to 0.085, and if it is increased by 30%, the weight decreases again

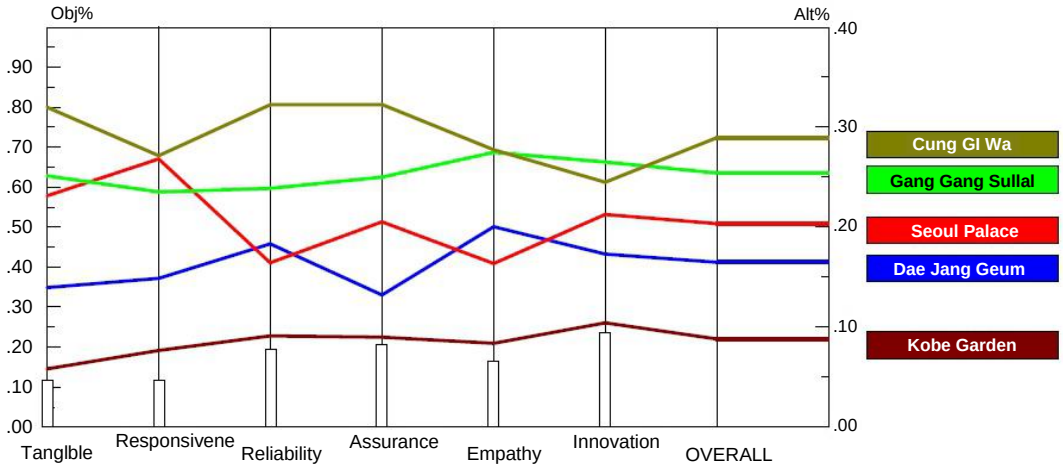

Figure 4. Performance sensitivity of alternatives.

Table 5. The results of sensitivity analysis

	Seoul Palace (Rank/Weight)	Kobe Garden (Rank/Weight)	Chung Gi Wa (Rank/Weight)	Dae Jang Geum (Rank/Weight)	Gang Gang Sullai (Rank/Weight)
Original	(3/0.204)	(5/0.179)	(1/0.217)	(4/0.194)	(2/0.206)
T is increased by 10%	(3/0.206)	(5/0.086)	(1/0.292)	(4/0.163)	(2/0.254)
T is increased by 25%	(3/0.206)	(5/0.085)	(1/0.292)	(4/0.162)	(2/0.254)
T is increased by 50%	(3/0.208)	(5/0.084)	(1/0.294)	(4/0.161)	(2/0.254)
R is increased by 10%	(3/0.208)	(5/0.087)	(1/0.288)	(4/0.164)	(2/0.253)
R is increased by 25%	(3/0.210)	(5/0.087)	(1/0.288)	(4/0.163)	(2/0.252)
R is increased by 50%	(3/0.213)	(5/0.087)	(1/0.287)	(4/0.163)	(2/0.251)
E is increased by 10%	(3/0.202)	(5/0.088)	(1/0.289)	(4/0.166)	(2/0.255)
E is increased by 25%	(3/0.201)	(5/0.088)	(1/0.289)	(4/0.167)	(2/0.255)
E is increased by 50%	(3/0.199)	(5/0.088)	(1/0.288)	(4/0.169)	(2/0.256)
A is increased by 10%	(3/0.203)	(5/0.088)	(1/0.290)	(4/0.164)	(2/0.254)
A is increased by 25%	(3/0.204)	(5/0.088)	(1/0.291)	(4/0.163)	(2/0.254)
A is increased by 50%	(3/0.204)	(5/0.088)	(1/0.293)	(4/0.161)	(2/0.253)
L is increased by 10%	(3/0.202)	(5/0.088)	(1/0.290)	(4/0.166)	(2/0.254)
L is increased by 25%	(3/0.201)	(5/0.088)	(1/0.291)	(4/0.166)	(2/0.253)
L is increased by 50%	(3/0.199)	(5/0.089)	(1/0.293)	(4/0.167)	(2/0.252)
I is increased by 10%	(3/0.204)	(5/0.089)	(1/0.288)	(4/0.165)	(2/0.254)
I is increased by 25%	(3/0.204)	(5/0.089)	(1/0.286)	(4/0.166)	(2/0.255)
I is increased by 50%	(3/0.205)	(5/0.091)	(1/0.283)	(4/0.166)	(2/0.256)

to 0.084. Overall, when the weight of tangible is increasing, the global weight of Seoul Palace and Chung Gi Wa are increasing, while the global weight of Kobe Garden, Dae Jang Geum, and Gang Gang Sullai are decreasing. When the responsiveness (R) is increased by 10%, the global weight of Dae Jang Geum decreases from 0.194 to 0.164; and it is increased by 25%, the weight of Dae Jang Geum decreases to 0.163, and also when the responsiveness is increased by 50%. Increasing empathy (E) by 10%, the global weight of Seoul Palace would decrease to 0.202. When the empathy is increased by 25%, the global weight of Seoul Palace would decrease as well to 0.201. Table 5 lists all of results of changing the attributes of five Korean restaurants. The previous situation demonstrates the conclusion of the sensitivity analysis. Regardless of how tangibles, responsiveness, empathy, assurance, reliability, and innovation are changed, the estimated ranking remains unchanged. It indicates that the ranking of the alternatives are not sensitive with the small changing of the weights of the attributes.

5. CONCLUSION AND FUTURE RESEARCH DIRECTION

The study aims to develop a model to evaluate the service quality of the Korean restaurants in Semarang. Data are collected from five experts who frequently visit Korean restaurants in the city and have affection in Korean cuisine. The result of this research as depicted in Table 3 and 4 show that Korean restaurants should focus more on innovation, assurance, and reliability aspects to perform satisfactory service. The ranking of the Korean restaurants in performance based on the calculations is: Chung Gi Wa (21.7%), Gang Gang Sullai (20.6%), Seoul Palace (20.4%), Dae Jang Geum (19.4%), and Kobe Garden (17.9%). It does not mean that the Chung Gi Wa has a gorgeous service with the others. In fact, other restaurants should improve their service quality considering these attributes. The findings can provide Korean restaurants' managers with valuable insights into the attributes that reflects customers' service quality perceptions.

There can be other method to evaluate the service quality of restaurants. It is highly recommended to utilize the other tools such as analytic network process (ANP) by Saaty (1996). ANP can be used if it is suspected that there are interdependent relationships among attributes. It is more interesting to study when the attributes are not assumed independent. However, in this study, the attributes are assumed independent. Another technique which could be used is technique for order preference by similarity to ideal solution (TOPSIS) by Hwang and Yoon (1981). TOPSIS has been modified to be employed in a fuzzy environment called fuzzy TOPSIS. There are many applications of fuzzy TOPSIS in the literature, such as Dymova *et al.* (2013), Kannan *et al*. (2014), and Roszkowska and Wachowicz (2015). Further research may be the application of these methods to evaluate the service quality of restaurants, especially Korean restaurants and compare the results with this research. Since this study have developed a new multiple-item scale for evaluating service quality of restaurants, especially for Korean restaurants which have distinctive characteristics among other ethnic or culture-based restaurants, validating the scale in other culture-based restaurants could be the future research as well. To be more generalized, further research is also needed to determine whether there are other attributes for evaluating the service quality of restaurants, especially for culture-based restaurants (e.g., China restaurants, French restaurants, western restaurants), such as price, professionalism, or the quality of the food.

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<APPENDIX> Questionnaire

The questionnaire with respect to the overall goal to find out the best service quality performance of Korean restaurant in Semarang, Indonesia, is given below:

A. Pairwise comparison for attributes.

Q1. How important is tangibles when it is compared with responsiveness?
Q2. How important is tangibles when it is compared with empathy?
Q3. How important is tangibles when it is compared with assurance?
Q4. How important is tangibles when it is compared with reliability?
Q5. How important is tangibles when it is compared with innovation?
Q6. How important is responsiveness when it is compared with empathy?
Q7. How important is responsiveness when it is compared with assurance?
Q8. How important is responsiveness when it is compared with reliability?
Q9. How important is responsiveness when it is compared with innovation?
Q10. How important is empathy when it is compared with assurance?
Q11. How important is empathy when it is compared with reliability?
Q12. How important is empathy when it is compared with innovation?
Q13. How important is assurance when it is compared with reliability?
Q14. How important is assurance when it is compared with innovation?
Q15. How important is reliability when it is compared with innovation?

B. Pairwise comparison for sub-attribute: Tangibles.

Q16. How important is creating attractive Korean environment when it is compared with showing appearance of Korean nuance?
Q17. How important is creating attractive Korean environment when it is compared with keeping cleanliness of tableware and dining environment?
Q18. How important is creating attractive Korean environment when it is compared with offering clear and legible menu?
Q19. How important is creating attractive Korean environment when it is compared with creating pleasant dining atmosphere?
Q20. How important is showing immaculate appearance when it is compared with keeping cleanliness of tableware and dining environment?
Q21. How important is appearance of Korean nuance when it is compared with offering clear and legible menu?
Q22. How important is appearance of Korean nuance when it is compared with creating pleasant dining atmosphere?
Q23. How important is keeping cleanliness of tableware and dining environment when it is compared with offering clear and legible menu?
Q24. How important is keeping cleanliness of tableware and dining environment when it is compared with creating pleasant dining atmosphere?
Q25. How important is offering clear and legible menu when it is compared with creating pleasant dining atmosphere?

C. Pairwise comparison for sub-attribute: Responsiveness.

Q26. How important is providing enthusiastic service when it is compared with possessing Korean cuisine knowledge?
Q27. How important is providing enthusiastic service when it is compared with showing ability to deal with emergencies?
Q28. How important is providing enthusiastic service when it is compared with providing activity information actively?
Q29. How important is possessing Korean cuisine when it is compared with showing ability to deal with emergencies?
Q30. How important is possessing Korean cuisine when it is compared with providing activity information actively?
Q31. How important is showing ability to deal with emergencies when it is compared with providing activity information actively?

D. Pairwise comparison for sub-attribute: Empathy.

Q32. How important is displaying positive concern for individual customers when it is compared with providing meticulous service?
Q33. How important is displaying positive concern for individual customers when it is compared with having flexible rules with customers?
Q34. How important is displaying positive concern for individual customers when it is compared with considering customers' requests in advance?
Q35. How important is providing meticulous service when it is compared with having flexible rules with customers?
Q36. How important is providing meticulous service when it is compared with considering customers' requests in advance?
Q37. How important is having flexible rules with customers when it is compared with considering customers' requests in advance?

E. Pairwise comparison for sub-attribute: Assurance.

Q38. How important is displaying good communication manners when it is compared with having well-trained employees?
Q39. How important is displaying good communication manners when it is compared with exhibiting capability of answering customer questions?
Q40. How important is displaying good communication manners when it is compared with offering customers a sense of security?
Q41. How important is having well-trained employees when it is compared with exhibiting capability of answering customer questions?
Q42. How important is having well-trained employees when it is compared with offering customers a sense of security?
Q43. How important is exhibiting capability of answering customer questions when it is compared with offering customers a sense of security?

F. Pairwise comparison for sub-attribute: Reliability.

Q44. How important is delivering guaranteed and timely service when it is compared with presenting correct bills?
Q45. How important is delivering guaranteed and timely service when it is compared with maintaining and cleaning the environment and facilities regularly?
Q46. How important is delivering guaranteed and timely service when it is compared with serving tasty food that meets customers' demand?
Q47. How important is presenting correct bills when it is compared with maintaining and cleaning the environment and facilities regularly?
Q48. How important is presenting correct bills when it is compared with serving tasty food that meets customers' demand?
Q49. How important is maintaining and cleaning the environment and facilities regularly when it is compared with serving tasty food that meets customers' demand?

G. Pairwise comparison for sub-attribute: Innovation.

Q50. How important is offering innovative menu when it is compared with providing customized services?
Q51. How important is offering innovative menu when it is compared with offering innovative activities?
Q52. How important is providing customized services when it is compared with offering innovative activities?