



Fuzzy numbers and TOPSIS to analyze service quality in the apartment lodging industry

Consumer Behavior in Tourism Symposium
(CBTS 2013)

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December 4-7, 2013



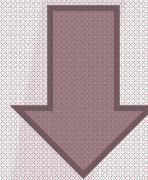
1. Current context

- ✓ Today tourism industry firms are involved in a changing global environment which prompts them to face an increasing competition
- ✓ By this, they are forced to search for strategic, competitive advantage and alternative profitable ways to differentiate themselves
- ✓ Improving customer services by delivering higher quality has become a powerful tool for achieving this goal
- ✓ Service quality plays a critical role in adding value to the tourist experience

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2. Service quality

- ✓ Service quality can not be measured in an objective way, as it can be done with manufactured goods.
- ✓ Its evaluation is more complex due to its heterogeneous and ephemeral nature, its inseparability of production and consumption and its intangibility.



Difficult to define and measure

2. Service quality

It is essential to understand how consumers perceive the service offered and the manner in which it is positioned in their minds.

“The first determinant of overall customer satisfaction is perceived quality”.

Fornel et al. (1996)

2. Service quality

Consumers judge service offered on a limit set of attributes, some of which are relatively important in determining satisfaction, while others are not critical to consumer satisfaction but are related to dissatisfaction when performance on them is unsatisfactory.

(Swan and Combs, 1976)

3. Methodology: Fuzzy Numbers

- ✓ Linguistic terms, satisfaction degree and importance degree are often vague. For example, lingual expressions, such as satisfied, fair, dissatisfied, are usually regarded as natural representations of consumers' preferences or judgements.
- ✓ Fuzzy set theory aids in measuring the ambiguity of concepts that are associated with human beings' subjective judgements.
- ✓ Modeling using fuzzy sets has proven to be an effective way for formulating decision problems where the information available is subjective and imprecise (Zimmermann, 1996)

3. Methodology: Fuzzy Numbers

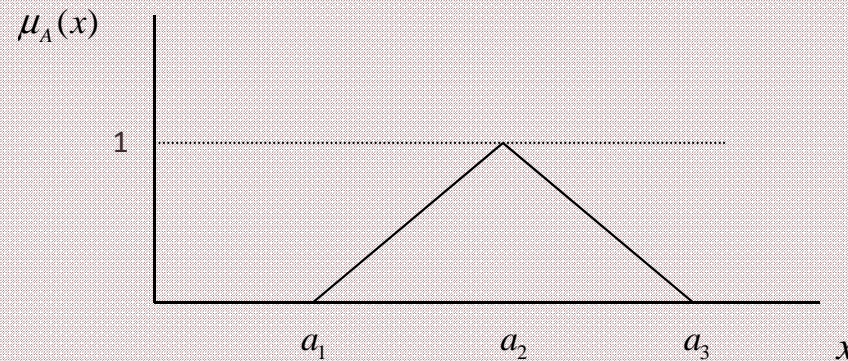
- ✓ In order to set up vagueness of linguistic terms, vague logical statements enable the formation of algorithms that can use vague data to derive vague inferences

Membership function





$$\mu_A(x) = \begin{cases} \frac{x - a_1}{a_2 - a_1}, & a_1 \leq x \leq a_2, \\ \frac{x - a_3}{a_2 - a_3}, & a_2 \leq x \leq a_3, \\ 0, & \text{otherwise.} \end{cases}$$

3. Methodology: Fuzzy Numbers

Graphical Membership function



Triangular fuzzy numbers. Default values of linguistic terms.

Términos faciales				
Números Fuzzy	(0,0,50)	(30,50,70)	(50,70,90)	(70,100,100)

3. Methodology: Fuzzy Numbers

- ✓ In order to provide more objective information for hotel managers, we have aggregated group opinions of consumers according to the average fuzzy number of n triangular numbers

$$\tilde{A} = (a_1, a_2, a_3) = \left(\frac{1}{n} \right) \bullet (\tilde{A}_1 \oplus \tilde{A}_2 \oplus \dots \oplus \tilde{A}_n) = \left(\frac{\sum_{i=1}^n a_1^{(i)}, \sum_{i=1}^n a_2^{(i)}, \sum_{i=1}^n a_3^{(i)}}{n} \right)$$

3. Methodology: Fuzzy Numbers

DEFUZZIFICATION

- ✓ We need to defuzzy the information obtained to justify whether a hotel attribute is weak or strong
- ✓ Defuzzification is a technique to convert the fuzzy number into crisp real numbers. The procedure of defuzzification is to locate the Best Nonfuzzy Performance (BNP) value
- ✓ We compare the performance of two triangular fuzzy numbers using $v_{\tilde{A}} = (a_1 + 2a_2 + a_3) / 4$ for the triplet (a_1, a_2, a_3)

3. Methodology: Fuzzy Numbers

TOPSIS approach

- ✓ We need to resolve the multi-attribute evaluation problem characterized by the crisp performance matrix
- ✓ We employ the TOPSIS approach
- ✓ TOPSIS defines the positive ideal solution and the negative ideal solution: the positive ideal solution is the solution that maximizes the benefit criteria and minimizes the cost criteria; whereas the negative ideal solution has got the opposite logic, i.e., maximizes the cost criteria and minimizes the benefit criteria. The optimal observation is the one, which is closest to the ideal solution and farthest to the negative ideal solution

3. Methodology: Fuzzy Numbers

TOPSIS approach

- ✓ The ranking of alternatives in TOPSIS is based on “the relative similarity to the ideal solution”

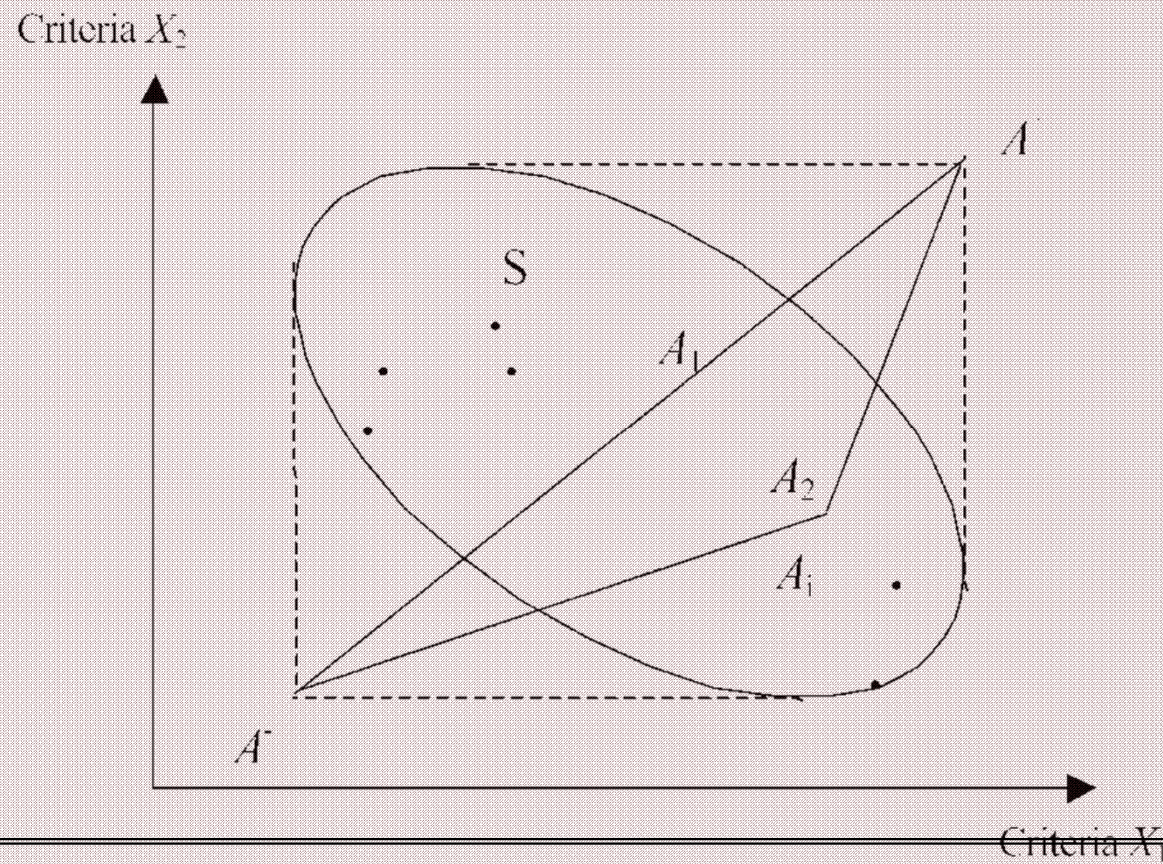
Positive and negative ideal solutions

$$A^+ = \left\{ \left(\max V_{ij} \mid j \in J \right), \left(\min V_{ij} \mid j \in J' \right), i = 1, 2, \dots, m \right\}$$

$$A^- = \left\{ \left(\min V_{ij} \mid j \in J \right), \left(\max V_{ij} \mid j \in J' \right), i = 1, 2, \dots, m \right\}$$

3. Methodology: Fuzzy numbers

Distance between positive ideal solution and negative ideal solution



3. Methodology: Fuzzy Numbers

TOPSIS approach

Euclidean distance between ideal solution and negative ideal solution

$$S_i^+ = \text{dist}(V_i, A^+) = \sqrt{\sum_{j=1}^n (V_{ij} - A_j^+)^2} \quad i = 1, 2, \dots, m$$

$$S_i^- = \text{dist}(V_i, A^-) = \sqrt{\sum_{j=1}^n (V_{ij} - A_j^-)^2} \quad i = 1, 2, \dots, m$$

Relative closeness to the positive ideal solution

$$C_i = \frac{S_i^-}{S_i^+ + S_i^-} \quad i = 1, 2, \dots, m$$

4. Service quality attributes

Service quality attributes of own satisfaction surveys

General

Condition of the complex

General cleanliness of the different areas

Overall condition of the garden

Overall condition of the pool area

Quality of the beach

Room

Cleanliness and linen change

Size of the room

Room amenities (TV, balcony, safe, etc.)

Size of the bathroom

Location and surroundings

Shopping facilities in the area

Transportation services and available excursions

Restaurants and bars in the area

Other leisure activities available

Distance to the beach

Service

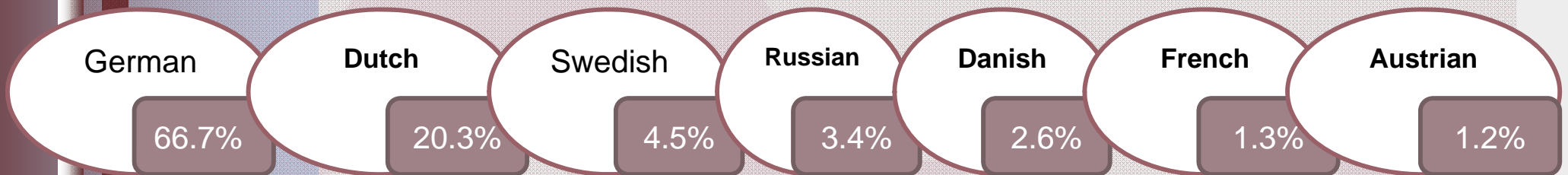
Friendliness and helpfulness

Staff's knowledge of foreign language

Reception, check-in and check-out

Competence (handling complaints)

5. Tourist's profile



69% older than 40 years old

Average length of stay of 12.5 days (7 days minimum and 30 days maximum)

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164 surveys

March 2012 – February 2013

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6. Empirical study

Fuzzy Numbers

Service quality evaluation criteria	March 2012	July 2012	November 2012	February 2013
Condition of the hotel	(63.33 , 90.00 , 96.67)	(68.33 , 97.50 , 99.17)	(70.00 , 100.00 , 100.00)	(60.00 , 85.00 , 95.00)
General cleanliness of the different areas	(63.33 , 90.00 , 96.67)	(70.00 , 100.00 , 100.00)	(70.00 , 100.00 , 100.00)	(66.00 , 94.00 , 98.00)
Overall condition of the garden	(70.00 , 100.00 , 100.00)	(66.67 , 95.00 , 98.33)	(66.36 , 95.45 , 97.27)	(66.67 , 95.00 , 98.33)
Overall condition of the pool area	(63.33 , 90.00 , 96.67)	(68.18 , 97.27 , 99.09)	(68.18 , 97.27 , 99.09)	(60.00 , 86.67 , 93.33)
Quality of the beach	(50.00 , 70.00 , 90.00)	(60.91 , 87.27 , 94.55)	(62.73 , 90.00 , 95.45)	(42.00 , 62.00 , 82.00)
Cleanliness and linen change	(63.33 , 90.00 , 96.67)	(65.00 , 93.33 , 96.67)	(66.00 , 94.00 , 98.00)	(56.67 , 80.00 , 93.33)
Size of the room	(56.67 , 80.00 , 93.33)	(65.00 , 92.50 , 97.50)	(62.73 , 90.00 , 95.45)	(53.33 , 76.67 , 90.00)
Room amenities (TV, balcony, safe, etc.)	(63.33 , 90.00 , 96.67)	(66.67 , 95.00 , 98.33)	(66.36 , 94.55 , 98.18)	(56.67 , 80.00 , 93.33)
Size of the bathroom	(50.00 , 70.00 , 90.00)	(68.33 , 97.50 , 99.17)	(66.36 , 94.55 , 98.18)	(63.33 , 90.00 , 96.67)
Shopping facilities in the area	(63.33 , 90.00 , 96.67)	(63.33 , 90.00 , 96.67)	(60.91 , 87.27 , 94.55)	(60.00 , 85.00 , 95.00)
Transportation connections and available excursions	(50.00 , 70.00 , 90.00)	(63.33 , 90.83 , 95.83)	(64.00 , 91.00 , 97.00)	(62.00 , 88.00 , 96.00)
Restaurants and bars in the area	(56.67 , 80.00 , 93.33)	(65.00 , 92.50 , 97.50)	(56.36 , 80.91 , 90.91)	(46.67 , 66.67 , 86.67)
Other leisure activities available	(50.00 , 70.00 , 90.00)	(60.00 , 85.00 , 95.00)	(55.00 , 80.00 , 90.00)	(50.00 , 70.00 , 90.00)
Distance to beach	(56.67 , 80.00 , 93.33)	(66.67 , 95.00 , 98.33)	(60.91 , 87.27 , 94.55)	(56.00 , 80.00 , 90.00)
Friendliness and helpfulness	(70.00 , 100.00 , 100.00)	(66.67 , 95.00 , 98.33)	(68.00 , 97.00 , 99.00)	(70.00 , 100.00 , 100.00)
Staff's knowledge of foreign language	(63.33 , 90.00 , 96.67)	(59.09 , 84.55 , 93.64)	(57.00 , 81.00 , 92.00)	(53.33 , 76.67 , 90.00)
Reception, check-in and check-out	(63.33 , 90.00 , 96.67)	(68.33 , 97.50 , 99.17)	(64.00 , 92.00 , 96.00)	(62.00 , 88.00 , 96.00)
Competence (handling complaints)	(56.67 , 80.00 , 93.33)	(62.73 , 90.00 , 95.45)	(65.00 , 93.75 , 96.25)	(66.67 , 95.00 , 98.33)

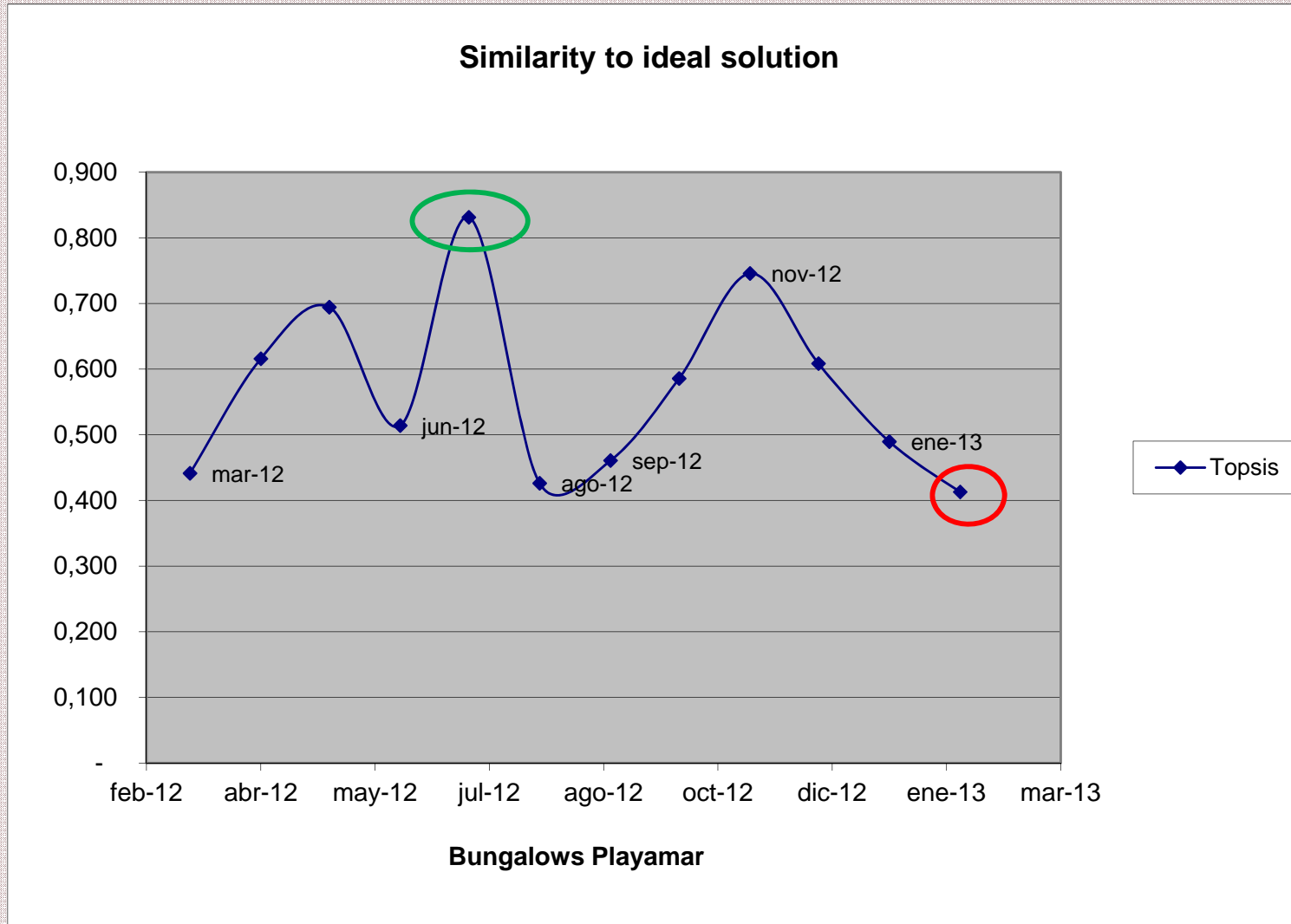
6. Empirical study

Overall performance measures

Service quality evaluation criteria	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12	Jan-13	Feb-13
Condition of the hotel	85.00	86.29	85.83	83.33	90.63	80.14	86.88	86.88	92.50^b	89.04	74.50^w	81.25
Overall condition of the garden	92.50^b	86.17	84.71^w	87.62	88.75	86.25	86.88	92.50	88.64	86.88	88.00	88.75
Overall condition of the pool area	85.00	86.17	82.21	84.40	90.45	77.78^w	83.13	92.50^b	90.45	87.31	88.00	81.67
General cleanliness of the different areas	85.00	88.98	86.44	81.19	92.50^b	80.14^w	86.88	86.88	92.50	87.31	88.00	92.50
Cleanliness and linen change	85.00	86.95	85.09	82.26	87.08	76.81^w	81.67	86.88	88.00^b	79.62	83.50	77.50
Size of the bathroom	70.00^w	87.66	87.31	82.26	90.63^b	82.78	81.25	86.88	88.41	87.31	83.50	85.00
Size of the room	77.50	85.47	85.93	79.05	86.88^b	77.78	85.00	86.88	84.55	82.31	75.00	74.17^w
Room amenities (TV, balcony, safe, etc.)	85.00	86.17	85.83	83.33	88.75	79.31	81.25	92.50^b	88.41	80.77	88.00	77.50^w
Friendliness and helpfulness	92.50^b	90.39	88.17	84.31	88.75	91.18	79.79 ^w	86.88	90.25	88.75	88.00	92.50
Reception, check-in and check-out	85.00	88.98	88.75	83.06	90.63^b	86.03	76.67^w	86.88	86.00	88.75	88.00	83.50
Competence (handling complaints)	77.50	87.10	87.21	89.04	84.55	83.67	76.39^w	92.50^b	87.19	80.00	92.50	88.75
Staff's knowledge of foreign language	85.00^b	78.67	80.42	78.19	80.45	79.33	70.83^w	75.63	77.75	74.17	79.00	74.17
Restaurants and bars in the area	77.50	74.77	84.50	75.36	86.88^b	74.44	81.46	81.25	77.27	77.31	72.00	66.67^w
Transportation connections and available excursions	70.00^w	75.60	82.70	79.50	85.21	76.25	73.00	70.63	85.75^b	84.55	83.50	83.50
Shopping facilities in the area	85.00	79.61	84.26	82.38	85.00	79.17	86.88^b	75.63^w	82.50	84.04	83.50	81.25
Quality of the beach	70.00	79.20	82.72	80.00	82.50	76.67	79.58	75.63	84.55^b	79.00	70.83	62.00^w
Distance to beach	77.50	83.59	81.85	80.24	88.75^b	80.28	77.50	81.25	82.50	85.58	79.00	76.50 ^w
Other leisure activities available	70.00	70.83	77.92	71.03	81.25^b	69.85	71.25	63.33^w	76.25	76.11	63.50	70.00

6. Empirical study

Overall performance measures



6. Empirical study

Overall performance measures

Global TOPSIS indicator

Date	Similarity to ideal solution	Rank
Jul-12	0.831	1
Nov-12	0.746	2
May-12	0.694	3
Apr-12	0.616	4
Dec-12	0.608	5
Oct-12	0.585	6
Jun-12	0.514	7
Jan-13	0.490	8
Sep-12	0.461	9
Mar-12	0.441	10
Aug-12	0.426	11
Feb-13	0.413	12

6. Empirical study

Coefficients of variation of some service quality attributes

Functional quality		Destination Quality	
Attribute	CV	Attribute	CV
Overall condition of the garden	0.0257	Shopping facilities in the area	0.0361
Service friendliness and helpfulness	0.0389	Distance to beach	0.0421
Reception, check-in & check-out	0.0415	Restaurants and bars in the area	0.0683
Room size	0.0555	Transportation connections and available excursions	0.0706
Competence	0.0595	Other leisure activities available	0.0717
Bathroom size	0.0606	Quality of beach	0.0804

6. Empirical study

Correlation coefficients (>0.75)

Paired-attributes	Value
Room amenities – Cleanliness and linen change	0.897
Room amenities – Condition of the pool area	0.820
Room size – Restaurants and bars in the area	0.819
Room size – Condition of the hotel	0.781
Room size - Quality of beach	0.780

7. Conclusions

- ✓ This study has contributed to the methodological advancement of service quality and tourism marketing literature
- ✓ The methodology of fuzzy numbers has been employed in order to solve the ambiguity of concepts associated to human linguistic expressions.
- ✓ The final ranking of this study shows that July 2012 was the month with the best overall performance. However, February 2013 obtained the worst performance.
- ✓ This work has also shown that tourist satisfaction regarding the service quality at destination has a greater heterogeneity than tourist satisfaction with functional quality, which is more homogeneous
- ✓ Room size and room amenities were found to be the variables with the highest degree of positive relation with variables such as cleanliness and linen change and condition of the pool area.

7. Conclusions

- ✓ The findings of this study may assist management with important insights to streamline their operations and enhance the quality of the tourist's experience by incorporating service quality aspects tourists value most.
- ✓ The survey is conducted without having in mind the treatment of fuzzy set theory methodology, and for this reason each respondent had not the option of defining a triangular fuzzy number more concordant with her/his perception
- ✓ It would be desirable to design a single model questionnaire in the region to compare data through the largest possible number of establishments. Future policy actions should consider this point and include such questions

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Thank you for your attention!

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