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# Assessing customer satisfaction of London luxury hotels with the AHP method and the SERVPERF scale: a case study of customer reviews on TripAdvisor

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## Abstract

Customer feedback and satisfaction are critical indicators of success in the hospitality industry. The influence of customer reviews on the decisions of other customers to visit and on the brand reputation of hotels necessitates that hotel managers conduct a thorough analysis of customer satisfaction. This paper presents an approach for assessing the overall customer satisfaction of hotels by using the Analytic Hierarchy Process (AHP) method, the SERVPERF scale, and the 2-tuple linguistic model. The five dimensions of the SERVPERF scale have been customized to assess customer satisfaction in hotels, considering various hotel aspects such as rooms, service, cleanliness, and so on. The AHP method is applied to obtain the importance of the SERVPERF scale for each aspect of the hotels. The 2-tuple linguistic model is employed to address the issue of information loss in linguistic information fusion and enhance the comprehensibility of the results for hotel managers. The functionality of this proposal has been evaluated through a case study of luxury hotels in London, using 15,511 customer reviews gathered from TripAdvisor. The results show that the proposed model effectively captures and summarizes customer satisfaction with luxury hotels in London, allowing hotel managers to identify areas for improvement and discover potential business opportunities. This ultimately helps to increase customer satisfaction.

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## 1. Introduction

Success relies heavily on customer loyalty in the highly competitive hospitality industry [1]. In the most advanced economies, hospitality contributes an average of over 10% to the gross domestic product (GDP). Hotel managers need to investigate customer satisfaction to make appropriate improvements to maintain their loyalty. As online platforms and review websites have grown in popularity, customer satisfaction is increasingly measured by online customer reviews. The SERVPERF scale is a frequently used tool for measuring customer satisfaction. Numerous studies in the literature have indicated that SERVPERF is more effective than SERVQUAL and has been applied in various industries [2-5]. However, SERVPERF typically assesses customer satisfaction through questionnaires rather than online customer reviews.

Therefore, this paper presents two novelties of the SERVPERF scale in measuring hotel customer satisfaction. It applies the AHP method to obtain the importance of the SERVPERF scale for each aspect of the hotel. This enables the transformation of online customer reviews related to various aspects of the hotel into the standardized SERVPERF scale. It is an advantage for analyzing the overall customer satisfaction levels. Moreover, the proposed model uses the 2-tuple linguistic model to aggregate customer reviews, ensuring no information is lost and increasing the interpretability of the results.

This paper chooses TripAdvisor as the platform to gather online customer reviews for luxury hotels in London due to its widespread recognition and popularity among customers [6]. The collected dataset consists of 15,511 customer reviews from November 21, 2017, to November 21, 2022. This dataset is utilized to test the functionality of the proposed model.

The rest of this paper is organized as follows. Section 2 introduces the fundamental concepts on which the proposed model is based. Section 3 presents a use case to assess the proposed model using 15,511 customer reviews of luxury hotels in London. Section 4 provides some conclusions and outlines future work.

## 2. Preliminaries

This section presents the elementary foundations on which the proposed model is based: the SERVPERF scale, the AHP method, and the 2-tuple linguistic model.

### 2.1. The SERVPERF scale

In the academic sector, various methods have been developed to measure service quality and customer satisfaction. Among these methods, two remarkable ones are SERVQUAL [7] and SERVPERF [8]. However, many researchers point to too high an assessment of customers' expectations as a weak point of SERVQUAL in the extensive literature on service quality [9]. As the SERVPERF developers have argued, exploring customer expectations is challenging due to their ambiguity and variability [8]. The main difference between SERVQUAL and SERVPERF is that SERVPERF does not rely on comparing customers' expectations and perceptions; instead, it solely evaluates the latter. SERVPERF is indeed less time-consuming and simpler.

The SERVPERF scale only considers customer perceptions as a measure of service quality. To measure customer satisfaction with the hotel taking into account factors such as rooms, service, cleanliness, etc., this paper modifies the concept of the five dimensions of the SERVPERF scale as follows:

- **Tangibles:** This dimension measures the physical facilities or equipment of the hotel, such as linens, furniture, and other amenities.
- **Reliability:** This dimension measures the ability to perform the promised service dependably and accurately, such as ensuring that the hotel rooms are always ready for check-in on time and that all amenities are functional.
- **Responsiveness:** This dimension measures the willingness to help customers and provide prompt service efficiently, such as promptly attending to guests' room service requests.
- **Assurance:** This dimension measures the ability to inspire guests' trust, such as having hotel staff who can provide recommendations for activities or restaurants nearby.
- **Empathy:** This dimension measures the ability to understand and respond to guests' needs and emotions, such as paying attention to guests with special requests or complaints.

## 2.2. The Analytical Hierarchy Process (AHP) method

Introduced by Thomas Saaty [10,11], the AHP method is a well-known decision-making technique that uses hierarchical decomposition to handle complicated information in Multi-Criteria Decision-Making (MCDM). It has been widely applied in various fields, including business and financial management [12-16], human resource management [17], logistics and supply chain management [18-20], engineering [21], healthcare [22-25], and so on.

The AHP method starts with setting a goal, then moves on to criteria used to assess the goal, and sub-criteria employed to evaluate the criteria. The weights of each of these criteria and sub-criteria are calculated using a pairwise comparison matrix, enabling decision-makers to evaluate various criteria and sub-criteria systematically. Table 1 shows Saaty's 9-point scale, which is frequently employed for pairwise comparison in the AHP method.

Table 1. Saaty's 9-point scale [10].

Intensity of importance	Definition	Explanation
1	Equal importance	Judgment favors both criteria equally.
3	Moderate importance	Judgment slightly favors one criterion.
5	Strong importance	Judgment strongly favors one criterion.
7	Very strong importance	One criterion is favored strongly over another.
9	Extreme importance	There is evidence affirming that one criterion is favored over another.
2, 4, 6, 8	Immediate values between above scale values	Absolute judgment cannot be given, and a compromise is needed.
Reciprocals of the above nonzero numbers	Reciprocals for inverse comparison	If criterion $i$ is assigned one of the above nonzero numbers when compared to criterion $j$ , then criterion $j$ has the reciprocal value when compared to $i$ .

However, it is necessary to check the consistency in the pairwise comparison matrix using the Consistency Ratio (CR) since these judgments are subjective and could be inconsistent. The CR is calculated by dividing the Consistency Index (CI) by the Random Index (RI), where  $CI = (\lambda_{max} - k)/(k - 1)$  with  $\lambda_{max}$  being the maximum eigenvalue of the pairwise comparison matrix and  $k$  being the number of criteria or sub-criteria compared, and RI is the consistency of a randomly generated pairwise comparison matrix. If the CR is less than or equal to 0.1, the pairwise comparison matrix is consistent, and the weight calculation can be performed. If the CR is higher than 0.1, it is necessary to revise the pairwise comparison matrix until it is consistent. More steps in the AHP method can be found in [26].

## 2.3. The 2-tuple linguistic model

The 2-tuple linguistic model is a model based on fuzzy logic and linguistic variable [27]. Herrera and Martínez developed this model to solve the issue of information loss in linguistic information fusion [28]. Numerous authors have utilized the 2-tuple linguistic model since it provides decision-makers with results that are easier to understand and interpret than those obtained solely through numerical scales [29-32].

The 2-tuple linguistic model represents the linguistic information using a pair of values known as a 2-tuple value  $(s_i, \alpha)$ , where  $s_i \in S$  is a linguistic term, and  $\alpha \in [-0.5, 0.5)$  represents the distance to the central value of  $s_i$ . The definition is as follows.

**Definition 1.** Let  $S = \{s_0, \dots, s_g\}$  be a linguistic term set, whose cardinality is  $g + 1$ .  $\beta \in [0, g]$  is a value that represents the result of a symbolic aggregation operation. The function  $\Delta: [0, g] \rightarrow \langle S \rangle = S \times [-0.5, 0.5)$  is used to convert  $\beta$  to 2-tuple value  $(s_i, \alpha)$  as shown in Equation (1):

$$\Delta(\beta) = (s_i, \alpha), \text{ with } \begin{cases} i = \text{round}(\beta) \\ \alpha = \beta - i, \alpha \in [-0.5, 0.5) \end{cases} \quad (1)$$

where  $\text{round}(\cdot)$  is the rounding operation;  $s_i$  has the nearest index label to  $\beta$ ; and  $\alpha$  represents a numerical value of the symbolic translation. As the function  $\Delta$  is bijective, its inverse function  $\Delta^{-1}: \langle S \rangle = Sx[-0.5, 0.5] \rightarrow [0, g]$  can convert the 2-tuple value into its equivalent numerical value as  $\Delta^{-1}(s_i, \alpha) = i + \alpha = \beta$ .

**Example 1.** The set of linguistic terms used on TripAdvisor to evaluate hotel aspects is  $S = \{s_0 = \text{Terrible} = T, s_1 = \text{Poor} = P, s_2 = \text{Average} = A, s_3 = \text{Very Good} = VG, s_4 = \text{Excellent} = E\}$ , with  $s_m < s_l$  for  $m < l$ , whose cardinality is  $g + 1 = 5$ . The distribution of this set  $S$  is shown in Fig. 1. If  $\beta = 2.9$ , its 2-tuple value will be  $\Delta(2.9) = (s_{\text{round}(2.9)}, 2.9 - \text{round}(2.9)) = (s_3, -0.1) = (VG, -0.1)$ . Its numerical transformation is done with the function  $\Delta^{-1}$ , which is  $\Delta^{-1}(s_3, -0.1) = 3 - 0.1 = 2.9$ . If  $\beta = 3$ , its 2-tuple value will be  $\Delta(3) = (s_{\text{round}(3)}, 3 - \text{round}(3)) = (s_3, 0) = (VG, 0)$ . The difference between  $\beta$  and that linguistic term is zero, that is  $(VG, 0) = VG$ .

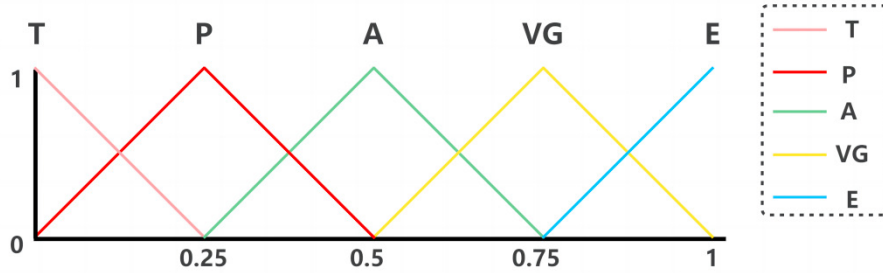


Fig. 1. A linguistic term set used on TripAdvisor.

The comparison between 2-tuple values, and the negation operator of a 2-tuple value applied to handle inverse dimensions can be found in [33]. The aggregation operator used in this paper to convert the ratings expressed in 2-tuple values of various hotel aspects into the five dimensions of the SERVPERF scale is defined as follows:

**Definition 2.** Let  $U_x = \{(s_1, \alpha_1), (s_2, \alpha_2), \dots, (s_t, \alpha_t)\}$  be a set of ratings expressed in 2-tuple values that the customer  $x$  evaluated regarding  $t$  aspects of the hotel, and  $W^k = \{w_1^k, w_2^k, \dots, w_t^k\}$  be their relative weights in the dimension  $k$  of the SERVPERF scale ( $k \in [1, 5]$ ). The 2-tuple value of the dimension  $k$  of the SERVPERF scale is calculated using Equation (2):

$$U_x^k = \Delta \left( \frac{\sum_{v=1}^t \Delta^{-1}(s_v, \alpha_v) \cdot w_v^k}{\sum_{v=1}^t w_v^k} \right) \quad (2)$$

where  $x = 1, \dots, n$ ,  $n$  is the number of customers who have evaluated the aspect  $v$  of the hotel.

### 3. Proposed model and application to the evaluation of luxury hotels

In this section, a model is proposed for aggregating customer reviews on TripAdvisor pertaining to luxury hotels in London. The main objective is to obtain a comprehensive assessment of customer satisfaction for luxury hotels on TripAdvisor by applying the SERVPERF Scale. This will enable luxury hotel managers to make more informed decisions regarding hotel management and improvement strategies. Fig. 2 shows the five steps contained in the proposed model.

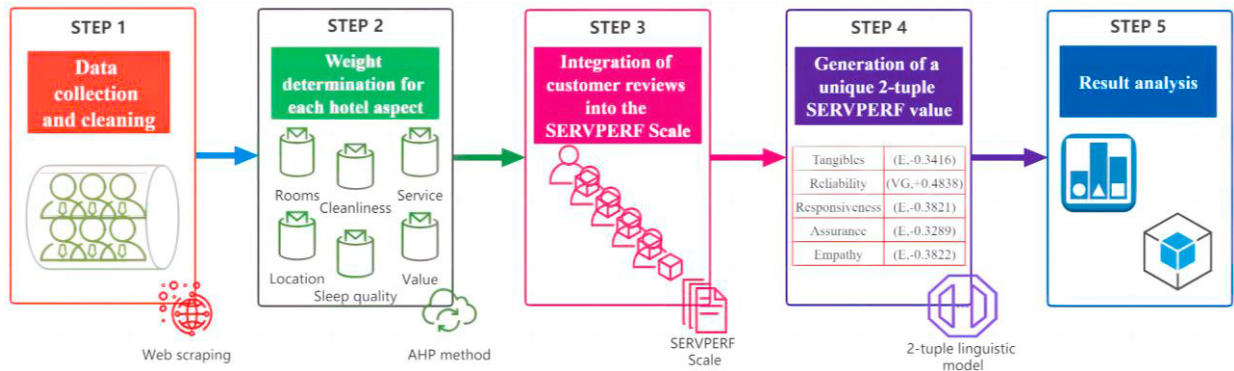


Fig. 2. Proposed model.

### 3.1. Data collection and cleaning

In November 2022, this study used Python-based Web crawlers to collect customer reviews about luxury hotels in London. The choice of London as the study location was based on the city's well-developed hospitality and tourism industry, and its popularity as a tourist destination. TripAdvisor was selected as the data source due to its widespread use by travelers [34,35].

The dataset obtained includes 258,610 customer reviews from more than 100 luxury hotels in London. Each customer review contains information on the User ID, User comment date, and ratings for various aspects of the hotel (rooms, service, cleanliness, sleep quality, location, value, business service, and check-in/front desk).

However, the business service and check-in/front desk are aspects of the hotel that are less frequently evaluated than other aspects by customers. Furthermore, even though the dataset contains reviews from as far back as 2010, the study only considers reviews from the past five years, from November 21, 2017, to November 21, 2022. This is because older reviews may not be useful for obtaining a precise evaluation of customer satisfaction for the hotel. Following the data cleaning process, a total of 15,511 customer reviews were included in the study.

### 3.2. Weight determination for each hotel aspect

This step used the AHP method to determine the weights of each hotel aspect associated with the five dimensions of the SERVPERF scale. First, experts and researchers with professional knowledge in the hotel industry created pairwise comparison matrices for each hotel aspect. Fig. 3 shows an example of the AHP tree for the hotel aspect "rooms" and the pairwise comparison matrix of the five dimensions of the SERVPERF scale related to this aspect. For the hotel aspect of "rooms," the Tangibles dimension is considered much more important than other dimensions because the condition of the physical facilities in the rooms plays a crucial role in customers' evaluation of this aspect.

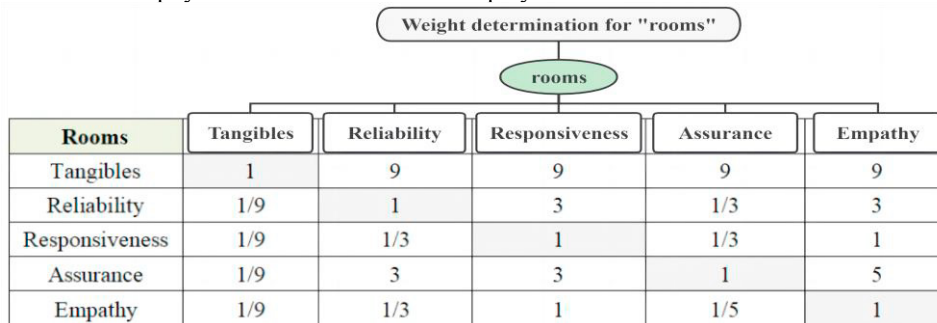


Fig. 3. AHP tree and the pairwise comparison matrix for the hotel aspect "rooms".

Table 2 shows the weights calculated for each hotel aspect against the five dimensions of the SERVPERF scale, as well as their corresponding CR. As shown in Table 2, all CR values are less than 0.1, which confirms the consistency of the pairwise comparison matrices and the validity of the experts' judgments.

Table 2. Weights of each hotel aspect in the SERVPERF scale.

Hotel Aspect	Tangibles	Reliability	Responsiveness	Assurance	Empathy	CR
rooms	67.3%	8.7%	4.5%	15.4%	4.1%	0.085
service	3.32%	31.23%	22.4%	11.82%	31.23%	0.079
cleanliness	40.55%	10.74%	5.36%	40.55%	2.8%	0.089
sleep quality	67.4%	9.1%	4.6%	14.3%	4.6%	0.078
location	52.41%	7.09%	3.55%	33.4%	3.55%	0.078
value	5.75%	68.44%	5.75%	14.31%	5.75%	0.034

### 3.3. Integration of customer reviews into the SERVPERF Scale

To gain a more comprehensive understanding of customer satisfaction, this step transformed customer reviews of different hotel aspects into the SERVPERF scale using Equation (2). Table 3 shows examples of the transformation results of some customer reviews into the five dimensions of the SERVPERF scale.

Table 3. Transformation of customer reviews into the SERVPERF Scale.

	rooms	service	cleanliness	sleep quality	location	value	Tangibles	Reliability	Responsiveness	Assurance	Empathy
1	E	E	VG	A	E	A	(VG, +0.21)	(VG, -0.23)	(VG, +0.44)	(VG, +0.25)	(E, -0.45)
2	A	E	A	A	VG	VG	(A, +0.27)	(VG, +0.02)	(VG, +0.17)	(VG, -0.45)	(VG, +0.38)
3	VG	A	A	VG	E	P	(VG, -0.01)	(A, -0.27)	(A, +0.23)	(VG, -0.37)	(A, +0.19)

### 3.4. Generation of a unique 2-tuple SERVPERF value

This step employed the arithmetic mean to aggregate the scores of the five dimensions derived from 15,511 customer reviews. The result was a single 2-tuple SERVPERF value assigned to each dimension of the SERVPERF scale, summarizing customer satisfaction with London luxury hotels and providing an overall evaluation of them. The customer review aggregation results for each dimension of the SERVPERF scale are shown in Fig. 4.

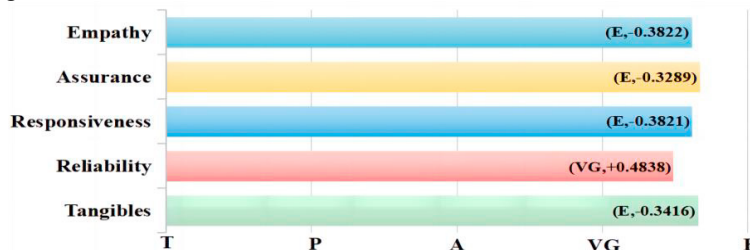


Fig. 4. 2-tuple SERVPERF value for London luxury hotels.

### 3.5. Result analysis

This step analyzed the results obtained by the proposed model. As shown in Fig.4, although most of the five dimensions of the SERVPERF scale have 2-tuple values close to E (i.e., Excellent), there is still room for improvement in the Reliability dimension for London luxury hotels. Since only luxury hotels were selected for measuring their customer satisfaction, it is evident that unsatisfactory findings should not be expected from their comprehensive

evaluation. However, it is essential to note that the integration of customer reviews into the SERVPERF Scale primarily focuses on the hotel aspects of "service" and "value" (see Tables 2 and 3) to determine the 2-tuple values for the Reliability dimension. These aspects significantly impact customer satisfaction regarding the Reliability dimension. Therefore, to align with the high-class demands of customers at luxury hotels in London and enhance their perception of value, hotel managers should carefully analyze how to improve this dimension swiftly.

#### 4. Conclusions and future work

This paper presents an approach for obtaining an overall evaluation of customer satisfaction in hotels using the AHP method, the SERVPERF scale, and the 2-tuple linguistic model. The proposed model utilized the AHP method to obtain the importance of the SERVPERF scale for each hotel aspect and incorporated the 2-tuple linguistic model to address the information loss problem in linguistic information fusion. Its functionality was tested using a dataset collected from online customer reviews about London luxury hotels from TripAdvisor. The results show that the proposed model can convert customer reviews concerning various hotel aspects into the five dimensions of the SERVPERF scale. It allows for the identification of the main factors that cause customer dissatisfaction.

The proposed model significantly contributes to hotel management by offering a comprehensive evaluation of luxury hotels. It can be used by hotel managers to identify areas for improvement and explore potential business opportunities, thereby enhancing customer satisfaction. This has the potential to increase profits and establish a competitive advantage.

However, this paper only focused on luxury hotels for data collection. To gain a more comprehensive understanding of the hotel industry, future research would collect data from other types of hotels and compare their results with that of luxury hotels. Moreover, it would be valuable to test the applicability of the proposed model in other industries, as the importance of each element varies across different sectors. The AHP method is a subjective methodology that requires expert evaluation and opinions to determine the weights. It would be beneficial to explore using more objective methods to determine the weights to enhance the robustness of the proposed model. Finally, although the 2-tuple linguistic model is a well-liked computing with words (CWW) approach, it would be advantageous to investigate different CWW methods in future work.

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