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A Novel Analysis on the Perception of Physical Environmental Quality: An In-Depth Study Comparing the Neutrosophic Likert Scale with Score Function and the Classic Likert Scale - Statistical Analysis of Data from a Restaurant Survey

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Abstract: There are studies examining the quality of the physical environment in the restaurant industry. However, these studies have only been conducted using Likert scale. Since the neutrosophic scale has not been used in the restaurant industry before, it is considered to be an important gap. For this reason, it is aimed to investigate the perceptions of physical environmental quality in restaurants by using Likert and neutrosophic scales for the first time. By applying Exploratory Factor Analysis, evidence is presented that a single factor adequately incorporates both scales, thus optimising the assessment procedure. Their consistency and reliability in assessing environmental perceptions is confirmed by the robust positive correlation between the two methods. Further investigations with one-way and two-way ANOVA reveal notable demographic differences, in particular the increased sensitivity of individuals aged 45 years and older towards the quality of the physical environment in restaurants. In contrast, gender has no effect on how environmental quality is perceived, suggesting that improvements in this area may resonate universally with consumers of all genders. The results of this study provide practical recommendations for restaurant managers seeking to improve business operations and customer satisfaction by emphasising environmental hygiene, especially for older customers. This research not only contributes to the body of knowledge regarding methodological approaches to environmental perception, but also sheds light on specific demographic preferences that can shed light on focused improvements in the restaurant industry.

Keywords: ANOVA, Likert scale, neutrosophic Likert scale, exploratory factor analysis, physical environment quality.

1. Introduction

As the increase in the number of restaurant establishments brings with it competition, it has become important for restaurants to be able to offer a physical service experience. The physical environment is an important element not only to maintain the loyalty of existing customers but also

to attract new customers [1]. The physical environment, which refers to the environment where product or service delivery takes place [2], is defined as an environment created by service providers, including general layout, design, decoration, and aesthetics [3]. As a key factor in attracting and satisfying customers in restaurant businesses, the physical environment has attracted attention among business managers [4]. It consists of all tangible and intangible elements inside or outside a restaurant [5]. It is stated that it is an important part of customers' evaluation of their satisfaction with the services they receive [6]. In this context, it is possible to say that the physical environment plays a critical role in differentiating the image of restaurant businesses, providing competitive advantage and influencing customer behavior [7-8-9-10-11-12]. Moreover, the physical environment can positively or negatively affect the customer's mood [13]. Restaurant businesses attach importance to the quality of the physical environment in order to differentiate from their competitors and increase their preferability. The physical environment has become a strategic element that restaurants pay attention to both in differentiating the atmosphere, changing the perception of the product or service, and ensuring that the first impression is positive. For this reason, it has been the subject of study by many researchers. This is because the quality of the physical environment is effective in the success of the restaurant business [14]. In this direction, studies on the use of the physical environment variable, which is the subject of the research, in Likert scales were examined. In the study conducted to examine the effects of physical environment, perceived value and image on customers' behavioural intentions in resort hotels in Malaysia, 280 questionnaires were distributed to hotels in two different tourist destinations. In this study, a five-point Likert scale was used. As a result of the study, it was found that guests with high perceptions of the physical environment were more likely to have positive perceived images, values and behavioural intentions [15]. A total of 340 questionnaires were distributed and analysed to test the relationships between physical environment, price perception, consumption emotions and customer satisfaction in resort hotels in China. The results of the analyses reveal that physical environment is an important determinant of consumption emotions and price perceptions, which in turn affect customer satisfaction. Moreover, consumption emotions and price perceptions significantly mediate the relationship between physical environment and customer satisfaction [16]. To examine the impact of physical environment on emotions, customer satisfaction and behavioural intentions in the Chinese resort hotel industry, 170 questionnaires were analysed. Respondents were asked to respond to all items using a 5-point Likert scale.

To examine the effect of hotel-restaurant image and physical environment, service, and food quality on satisfaction and intention, 308 questionnaires were distributed and analyzed. The study showed that the variables are generally significantly related; quality dimensions and satisfaction have a mediating role; satisfaction and overall image have a greater impact on decision-making than other variables [17]. To investigate the importance of the physical environment in terms of customer satisfaction in Bali, 105 participants were surveyed in 22 different restaurants. According to the research results, the most determinant factor of customer satisfaction is the atmosphere factor, followed by the aesthetic factor of the facility. The variable that determines customer satisfaction the most is comfortable room temperature, followed by clean furniture [18]. To reveal the relationship between the physical environment of a restaurant and price perception and to determine the effect of price perception on satisfaction and loyalty, a questionnaire was collected from 475 people who experienced first-class restaurants in Istanbul. As a result of the data obtained from this study using a seven-point Likert scale, it was concluded that there was no significant relationship between ambiance and decoration and price perception. In contrast, a significant relationship was found between layout and price perception [19].

To examine the effect of the physical environment and food quality on satisfaction and behavioral intentions, a questionnaire was applied to 130 participants who visited McDonald's point of sale. According to the results of the research, it was determined that food quality has a positive and significant effect on consumer satisfaction and physical environment has a positive and

significant effect on consumer satisfaction. The results also show that food quality has a positive and insignificant effect on behavioral intentions through consumer satisfaction, while the physical environment has a positive and insignificant effect on behavioral intentions through consumer satisfaction [20]. As a result of the literature review, it was determined that the neutrosophic scale has not been applied in the restaurant sector before. For this reason, it is aimed to evaluate how restaurant businesses that try to differentiate with their physical environment respond to two different questionnaires (Likert + neutrosophic) consisting of the same questions.

2. Likert Scale

The Likert rating scale, which is widely used in social sciences and attitude scores, can be a useful and reliable tool for measuring self-efficacy [21-22]. This scale developed by Rensis Likert was defined for the evaluation of attitudes [23]. It requires individuals to respond to a series of statements as strongly disagree, disagree, undecided, agree, or strongly agree. A point value is assigned to each response and the score of the individuals is determined by summing the point values of all statements [22-24]. Here, all statements reveal a particular dimension of attitude toward the topic, so they are necessarily interrelated [25]. The Likert scale is recognized as an easy and reliable scaling technique [26], where it is easy to measure and understand participant perception [27]. It is stated to be more manageable and fast compared to other scales [28]. However, there is a debate among researchers about the optimum number of options in a Likert-type scale. Some researchers prefer scales with 7-item responses [29].

However, although the Likert scale seems to be useful, it also has some disadvantages. There are uncertainties about whether the responses collected on the Likert scale should be ordinal or interval level [23-30] and how the data obtained should be analyzed [27]. This confusion has led many to use statistical methods such as mean and standard deviation, which are inappropriate for Likert scales [30]. In addition, participants' responses may be influenced by previous questions and their tendency to avoid selecting extreme possibilities on the scale is also problematic. Due to these uncertainties, it is thought that the Likert scale may not be the most appropriate scale to use in research. Therefore, this situation leads researchers to propose different scale types. To obtain more acceptable measurement findings, the Neutrosophic approach based on fuzzy sets theory was proposed as an alternative to the Likert scale in this study.

3. Neutrosophy and Neutrosophic Set

The philosophical and mathematical framework known as Neutrosophy [31] was created by Florentin Smarandache during the latter part of the 20th century. This particular field of study pertains to issues and principles that encompass indeterminacy, ambiguity, and contradictions. Neutrosophic logic offers an extension to classical, fuzzy, and intuitionistic fuzzy logic, enabling the representation of information that is uncertain, contradictory, and ambiguous. Classical logic entails assertions that can either be true or false, whereas neutrosophic logic allows claims to be true, false, and indeterminate at the same time. This enables a more sophisticated and adaptable approach to logical thinking. Neutrosophic set theory is an extension of classical, fuzzy, and intuitionistic fuzzy set theory that addresses the challenges posed by sets containing indeterminate or uncertain members. In classical set theory, an element is classified as either a member of a set or not. In neutrosophic set theory, an element can possess different levels of membership in a set, have no degree of membership in the set, or have no degree of membership in the set. Neutrosophic probability is an extension of the conventional theory of probability that addresses the challenges posed by unpredictable and uncertain events. In classical probability theory, events are characterized by well-defined probabilities ranging from 0 to 1. The correlation between events in neutrosophic probability and degrees of truth, falsehood, and indeterminacy allows for a more comprehensive depiction of uncertainty.

Neutrosophy has been utilized in many domains such as artificial intelligence [32], decision-making [33-34-35], information fusion [36], and risk analysis [37], where the effective management of uncertainty and ambiguity is of utmost importance. The paradigm presented offers a structured approach to addressing scenarios in which classical logic and probability theory may necessitate revision as a result of conflicting or uncertain data. In classical set theory, an element is classified as either a member of a set or not. The interpretation of the membership of elements in a set is based on binary terms, as per the binary case.

The single valued neutrosophic set [31-38] offers a comprehensive framework that encompasses intuitionistic fuzzy sets, classical sets, fuzzy sets, dialetheist sets, paradoxist sets, tautological sets, and intuitionistic fuzzy sets, all of which are rooted in the principles of Neutrosophy. An member x(T, I, F) is considered true in the set when its degree is T ∈ [0,1], ambiguous when its degree is I ∈ [0,1], and false when its degree is F ∈ [0,1].

In this section, we will provide fundamental definitions and concepts pertaining to single-valued neutrosophic sets, fuzzy sets, and intuitionistic fuzzy sets.

Definition 1. [39] A fuzzy set X in $\boldsymbol{U}$ is a set of ordered pairs, defined as $\boldsymbol{X} = \{(\boldsymbol{x}, \mu_{\boldsymbol{X}}(\boldsymbol{x}))|\boldsymbol{x} \in \boldsymbol{U}\}$, where $\mu_{\boldsymbol{X}} : \boldsymbol{U} \to [\boldsymbol{0}, \boldsymbol{1}]$ is termed the membership function of X, and $\mu_{\boldsymbol{X}}(\boldsymbol{x})$ is the degree of membership of the element x in X given a universal set U and a generic element, represented by x.

Definition 2. [40] An intuitionistic fuzzy set X exists over a discourse-level world. The representation of U is given by $\boldsymbol{X} = \{(\boldsymbol{x}, \mu_{\boldsymbol{X}}(\boldsymbol{x}), \boldsymbol{\nu}_{\boldsymbol{X}}(\boldsymbol{x}))|\boldsymbol{x} \in \boldsymbol{U}\}$, where the terms "membership function of X" and "non-membership function of X" for x in X are, respectively, $\mu_{\boldsymbol{X}} : \boldsymbol{U} \to [\boldsymbol{0}, \boldsymbol{1}]$ and $\boldsymbol{\nu}_{\boldsymbol{X}} : \boldsymbol{U} \to [\boldsymbol{0}, \boldsymbol{1}]$. The formula for determining the degree of non-membership of an element, x, in X is $\mu_{\boldsymbol{X}}(\boldsymbol{x}) + \boldsymbol{\nu}_{\boldsymbol{X}}(\boldsymbol{x}) \leq \boldsymbol{1}$. The hesitation degree of an element x defined by $\boldsymbol{\pi}_{\boldsymbol{X}}(\boldsymbol{x}) = \boldsymbol{1} - (\mu_{\boldsymbol{X}}(\boldsymbol{x}) + \boldsymbol{\nu}_{\boldsymbol{X}}(\boldsymbol{x}))$.

Definition 3. [31-38] Let U be a discourse universe. $\boldsymbol{N} = \{(\boldsymbol{x}, \boldsymbol{T}(\boldsymbol{x}), \boldsymbol{I}(\boldsymbol{x}), \boldsymbol{F}(\boldsymbol{x})) : \boldsymbol{x} \in \boldsymbol{U}\}$ is a neutrosophic set, denoted by a truth-membership function, $\boldsymbol{T}_{\boldsymbol{N}} : \boldsymbol{U} \to]^{-}\boldsymbol{0}, \boldsymbol{1}^{+}[$; an indeterminacy-membership function, $\boldsymbol{I}_{\boldsymbol{N}} : \boldsymbol{U} \to]^{-}\boldsymbol{0}, \boldsymbol{1}^{+}[$; and a falsity-membership function, $\boldsymbol{F}_{\boldsymbol{N}} : \boldsymbol{U} \to]^{-}\boldsymbol{0}, \boldsymbol{1}^{+}[$.

Definition 4. [31-38] Let U be a discourse universe. A single-valued neutrosophic set is defined as $\boldsymbol{N} = \{(\boldsymbol{x}, \boldsymbol{T}(\boldsymbol{x}), \boldsymbol{I}(\boldsymbol{x}), \boldsymbol{F}(\boldsymbol{x})) : \boldsymbol{x} \in \boldsymbol{U}\}$, which is identified by a truth-membership function, $\boldsymbol{T}_{\boldsymbol{N}} : \boldsymbol{U} \to [\boldsymbol{0}, \boldsymbol{1}]$; indeterminacy-membership function, $\boldsymbol{I}_{\boldsymbol{N}} : \boldsymbol{U} \to [\boldsymbol{0}, \boldsymbol{1}]$; and falsity-membership function, $\boldsymbol{F}_{\boldsymbol{N}} : \boldsymbol{U} \to [\boldsymbol{0}, \boldsymbol{1}]$, with $\boldsymbol{0} \leq \boldsymbol{T}_{\boldsymbol{N}}(\boldsymbol{x}) + \boldsymbol{I}_{\boldsymbol{N}}(\boldsymbol{x}) + \boldsymbol{F}_{\boldsymbol{N}}(\boldsymbol{x}) \leq \boldsymbol{3}$.

3.1. Neutrosophy in Social Sciences

Neutrosophic Sociology, also known as Neutrosociology, refers to the application of neutrosophic scientific procedures in the study of sociology, as defined by Smarandache [41]. The questionnaire is widely recognized as a crucial tool in surveys for assessing the state of opinions within social groups. While it is widely acknowledged that fuzzy responses are preferable to crisp responses in surveys, it is important to acknowledge that fuzzy processing may not accurately capture the intended meaning of the responder due to uncertainties, confusion, and unclear thinking. The utilization of neutrosophic sets in modeling such a scenario provides responders with an expanded range of potential responses, hence enhancing its relevance. [42]

In this paper, we propose a methodology for generating single-valued neutrosophic sets based on questionnaires administered to social groups. The study [43] provided a definition, demonstration, and introduction of neutrosophic statistical methods in the field of Social Sciences. Frequently, the data presented in the field of Social Sciences exhibit inconsistencies due to errors, conflicts in information and knowledge sources, lack of objectivity in some viewpoints, and various other factors. Consequently, it was asserted that under some conditions, the inclusion of interval data may be necessary.

3.2. Neutrosophic Score Function

Martinez et al. [42] employed the scoring function $s: [0,1] \rightarrow [0,3]$, denoted as $s(a) = 2+ T - I - F$, to quantify neutrosophic qualities and conduct a comparative analysis within the framework of social science. Nevertheless, our primary emphasis lies in the interpretation of the measurement pertaining to the impact of group decision-making on social choices. It is worth noting that this particular score function was not employed in a Likert-type study. The score function was initially employed in a Likert essay, and [42] demonstrated its safe applicability in the field of social sciences. In this study, we employ the $s(a) = (1 + T - 2I - F)/2$ function from the [44] publication. We believe it is appropriate for a starting workspace to consider the negative, neutral, and positive effects by distributing the score values across the [−1, 1] range, which aligns with the approach utilized in neutrosophic research.

3.3. Neutrosophic Likert Scale

The neutrosophic Likert scale was applied for the first time in the study [45]. Classical satisfaction with life scale Likert questions were transformed through numerical value between 0 and 100 was expected by participants to be given the options "I agree with this statement (…)", "I am neutral (or indeterminacy) about this statement (…)", "I disagree with this statement (…)". The results in the paper showed that the neutrosophic scale is also reliable, which supports the reliability of the classical scale because Cronbach's Alpha constant is an acceptable level for the three dimensions.

In our current study, we transform within the framework of direct percentage understanding to get closer to natural language. There is a connection between fuzzy sets and Neutrosophic Likert scales in the way they handle imprecision and uncertainty. Neutrosophic sets, and thus, Neutrosophic Likert scales, enable an even wider representation that incorporates indeterminacy as a core component, whereas fuzzy sets enable the representation and manipulation of data that is not exactly specified. For survey responses where participants' opinions are not only varied across a spectrum (as accommodated by fuzzy sets) but may also include a degree of indecision or neutrality that is difficult to capture by traditional fuzzy logic or crisp Likert scales, Neutrosophic Likert scales are therefore particularly well-suited.

4. Data and Likert Questionnaires

The survey questionnaire was administered to customers in the restaurant with the understanding that the identity of the respondents would be kept confidential, that participation could be withdrawn at any time, and that the data collected would be used only for the purposes of this study. G*Power 3.1.9.4 software determined that 135 participants were necessary for the survey. In addition, a 22-question survey was administered to 135 restaurant customers and four of them were selected to help assess the quality of the physical environment using a 5-point Likert scale (ranging from 1 for "strongly disagree" to 5 for "strongly agree") as shown in Table 1. Participants were directed to choose one of the five agreement levels while responding to the survey.

Table 1. Likert Scale Questions (responses should be marked with a check for one choice)

Questions	Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree
The restaurant has an attractive interior design and decor.	☐	☐	☑	☐	☐
The background music is pleasant.	☐	☑	☐	☐	☐
The dining areas are very clean.	☑	☐	☐	☐	☐
Staff are clean and well dressed.	☐	☐	☐	☑	☐

The neutrosophic scale (a: degree of agreement; b: degree of indeterminacy; c: degree of disagreement) was applied toward measuring physical environmental quality. These selected questions are shown in Table 2. Survey participants (the same participants previously surveyed, as shown in Table 1) selected a, b, c, and one percentile value each. According to the single-valued neutrosophic set approach, the sum of the percentiles (% values) of a + b + c was between 0 and 300; then, we took one percent of these percentage values and mapped them to the closed interval [0, 1].

Table 2. Neutrosophic Scale Questions (responses are required to be completed in percentages)

Questions	Agreement Degree	Indeterminacy Degree (Neither Agree Nor Disagree)	Disagreement Degree
The restaurant has an attractive interior design and decor.	40	60	50
The background music is pleasant.	20	40.5	10
The dining areas are very clean.	0	100	20
Staff are clean and well dressed.	0.5	25	75

Table 3 displays the demographic details of the survey respondents. The responses gathered from participants utilizing both the Likert and neutrosophic scales are illustrated in the tables below.

Table 3. Profile Information of the Survey Respondents (N = 135)

Variables	Categories	Number of Cases	Percentage (%)
Gender	Female	69	51.11
	Male	66	48.89
Age	18–25	44	32.59
	26-34	31	22.96
	35-44	24	17.78
	45-54	17	12.59
	55^{+}	19	14.07

Table 4. Participants' Responses on a Likert-Type Scale

	Q1	Q2	Q3	Q4
Strongly disagree	16	22	3	6
Disagree	7	25	4	1
Neither agree nor disagree	35	27	18	13
Agree	41	25	51	37
Strongly agree	36	36	59	78

Table 5. Participants' Responses on a Neutrosophic Scale

	Q1	Q2	Q3	Q4
Disagree	3	3	1	1
Neither agree nor disagree	50	59	30	19
Agree	82	73	104	115

Table 6. Responses Based on Likert Scale for all Questions

	All Questions
Strongly disagree	7
Disagree	10
Neither agree nor disagree	14
Agree	52
Strongly agree	52

Table 7. Responses Based on Neutrosophic Scale for all Questions

	All Questions
Disagree	15
Neither agree nor disagree	32
Agree	88

Agreeing, represented by the responses "Agree" and "Strongly Agree" on the Likert scale, is selected at a higher frequency compared to neutrosophic agreement. Likewise, disagreement, represented by "Disagree" and "Strongly Disagree" responses on the Likert scale, is selected at a higher frequency compared to the neutrosophic scale. In contrast, it is observed that the number of undecided responses (32) obtained with the Neutrosophic scale exceeds the number of undecided responses (14) obtained with the Likert scale.

5. Statistical Analysis

Quantitative data were analyzed using SPSS (IBM Corporation) and MATLAB software. Exploratory factor analysis (EFA) is a statistical method used to help classify comparable variables into sub-dimensions and to make observations less dimensional in order to make the data easier to understand. For this purpose, a factor analysis was conducted to determine the factor structure of Likert and neutrosophic scales to assess the quality of the physical environment. Kaiser-Meyer-Olkin (KMO) and Bartlett's test were conducted to assess the suitability of the scales for exploratory factor analysis. Kaiser-Meyer-Olkin (KMO) values were calculated as 0.686 and 0.683, respectively, and exceeded the acceptable value of 0.60 in exploratory factor analysis for both scales. In addition, Bartlett's test results for Likert and neutrosophic scales were $x^2 = 218.486$ ($p < 0.05$) and $x^2 = 211.023$ ($p < 0.05$), respectively, indicating that there were significant correlations between the items, in other words, the variances were not homogeneous, supporting the suitability of the data for exploratory factor analysis. Following the exploratory factor analysis, the Likert and neutrosophic scales, each consisting of 4 items, explained 64.082% and 63.176% of the total variance. These results,

as indicated in Figure 1 and Figure 2, suggest that a single component represents these scales well enough.

Figure 1. Scree Plot of the Likert Scale

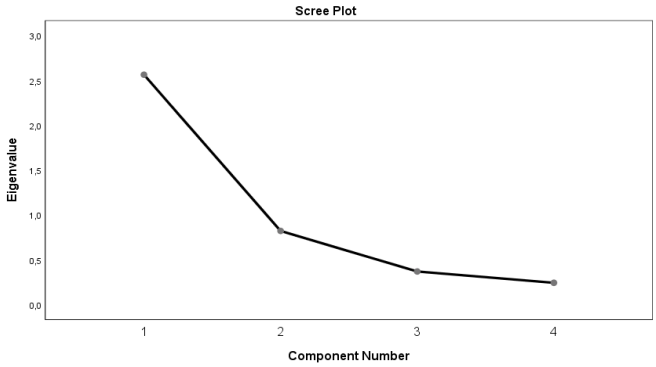
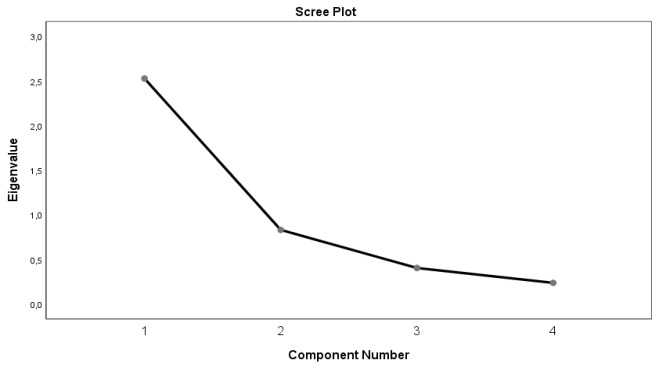


Figure 2. Scree Plot of the Neutrosophic Scale



Descriptive statistics for 135 participants, calculated for both scales used to assess physical environmental quality, are provided in Table 8.

Table 8. Descriptive Statistics

	Likert Scale	Neutrosophic Scale
Mean	15.267	2.321
Median	16.000	2.450
Mode	16.000	4.000
Std. deviation	3.702	1.247
Variance	13.704	1.555

Skewness	−0.935	-0.417
Std. error of skewness	0.209	0.209
Kurtosis	0.596	−0.896
Std. error of kurtosis	0.414	0.414
Range	16.000	4.400
Minimum	4.000	−0.400
Maximum	20.000	4.000

Regarding descriptive statistics, the Likert scale with values ranging from 1 to 5 had a mean of 15.267, while the neutrosophic scale ranging from -1 to 1 resulted in a mean of 2.321. Furthermore, the variance for the Likert scale is 13.704, while it is 1.555 for the neutrosophic scale, which shows that the neutrosophic scale has a lower arithmetic mean and standard deviation. Since the same sample size was used in both scales, the standard errors of skewness and kurtosis are the same. Skewness and kurtosis are used to describe the shape of a distribution.

The findings in Table 9 show that the Likert scale and the neutrosophic scale differ from the normal distribution at the 0.05 statistical significance level. However, especially in social sciences, skewness and kurtosis values can be an important tool for making statistical inferences about data distributions. For most psychometric purposes, skewness and kurtosis values of ±1.0 are considered perfect [36]. Therefore, given that the skewness and kurtosis values of both scales were ±1.0, parametric analyses were performed assuming that they conformed to a normal distribution.

Table 9. Normal Distribution Testing Using the Kolmogorov–Smirnov Test

	Kolmogorov–Smirnov		
	Statistic	**Df**	**Sig.**
Likert scale	0.136	135	0.000
Neutrosophic scale	0.093	135	0.006

Cronbach's alpha coefficient was calculated to assess the reliability of the scales [36]. According to the results in Table 10, it is seen that the scores obtained from the neutrosophic scale are similarly reliable to the Likert scale.

Table 10. Cronbach's Alpha Coefficient

Cronbach's Alpha Constant	**Variables**
0.798	SCORE1, SCORE2, SCORE3, SCORE4
0.785	VAR1a, VAR2a, VAR3a, VAR4a
0.700	VAR1b, VAR2b, VAR3b, VAR4b
0.804	VAR1c, VAR2c, VAR3c, VAR4c
0.795	VAR1, VAR2, VAR3, VAR4

Table 11. Independent Variable Importance

	Importance	**Normalized Importance**
Score1	0.227	65.8%
Score2	0.345	100.0%
Score3	0.215	62.4%
Score4	0.213	61.7%

According to the artificial neural network analysis findings of the two scales, Score4 had the least effect on the Likert scale with 61.7%, while Score2 had the greatest effect with 100.0%.

Table 12. Correlation among Classical Items, Neutrosophic Items, and Scores

		VAR1a	**VAR1b**	**VAR1c**	**Score1**
VAR1	Correlation Coefficient	0.779 **	-0.216 *	−0.660 **	0.753 **
	P	0.000	0.012	0.000	0.000
	N	135	135	135	135
		VAR2a	**VAR2b**	**VAR2c**	**Score2**
VAR2	Correlation Coefficient	0.803 **	-0.064	−0.742 **	0.749 **
	P	0.000	0.458	0.000	0.000
	N	135	135	135	135
		VAR3a	**VAR3b**	**VAR3c**	**Score3**
VAR3	Correlation Coefficient	0.652 **	-0.371 **	−0.543 **	0.625 **
	P	0.000	0.000	0.000	0.000
	N	135	135	135	135
		VAR4a	**VAR4b**	**VAR4c**	**Score4**
VAR4	Correlation Coefficient	0.670 **	-0.423 **	−0.436 **	0.609 **
	P	0.000	0.000	0.000	0.000
	N	135	135	135	135

** Correlation is significant at the 0.01 level. * Correlation is significant at the 0.05 level.

When Spearman's rho correlation coefficient is analyzed in Table 12, a significant positive correlation was found between the Likert scale and the neutrosophic scale for the "agree" option and scores. On the other hand, a significant negative correlation was found between Likert scale and neutrosophic scale for "undecided" and "disagree" options. In general, it is observed that there is a significant relationship between the items of the two scales.

According to the results in Table 13, there is a statistically significant and strong positive relationship between Likert and neutrosophic scales.

Table 13. Correlation between Neutrosophic Scale and Likert Scale

		Likert Scale
Neutrosophic scale	Pearson Correlation (r)	0.668 **
	P	0.000
	N	135

** Correlation is significant at the 0.01 level.

Table 14. Paired Samples T-Test Results for the Likert and Neutrosophic Scales

		Mean	**SD**	**t**	**Df**	***p***	**d**
Pair 1	Likert scale-Neutrosophic scale	12.946	3.016	49.879	134	0.000	4.292

d = Effect size.

According to the results of Table 14, paired samples t-test were significant, t(134) = 49.879 showing that there was a significant difference in the Likert scale, Mean = 15.267, SD = 3.702, n = 135, compared to the neutrosophic scale, Mean = 2.321, SD = 1.247, n = 135. As per Cohen's guidelines, the effect size was identified as considerably large [39]. The mean difference was 12.946, with the 95% confidence interval for the difference between the means ranging from 12.433 to 13.459. Consequently, the null hypothesis that there is no significant difference between the two scales was rejected.

In Table 15, the mean and standard deviation are calculated to describe the central tendency and spread of the two scales, respectively (Table 7, [39]). These values provide valuable information about data distribution and variability, allowing researchers to make informed decisions and draw meaningful conclusions.

Table 15. Mean and Standard Deviation of the Population's Attitudes toward Physical Environmental Quality through both the Likert Scale and Neutrosophic Scale

Item	Likert Scale		Neutrosophic Scale	
	μ	σ	μ	σ
The restaurant has an attractive interior design and decor.	3.548	1.268	0.488	0.418
The background music is pleasant.	3.207	1.436	0.423	0.444
The dining areas are very clean.	4.178	0.929	0.681	0.364
Staff are clean and well dressed.	4.333	1.000	0.729	0.347

μ = Arithmetic mean, σ = Standard deviation.

Table 15 shows that the arithmetic mean and standard deviation of the Neutrosophic scale are lower than the Likert scale. A low standard deviation indicates that the data points tend to be closer to the mean, while a high standard deviation indicates that the data points are spread over a wider range. Therefore, it can be said that the neutrosophic scale has a distribution closer to the mean, while the Likert scale has a wider distribution.

Table 16. One-Way ANOVA Results for the Likert and Neutrosophic Scales

Scale	Effect	Mean Square	F	Significance Level
Likert scale	Age	54.319	4.361	0.002
Neutrosophic scale	Age	4.765	3.272	0.014

A one-way ANOVA with five age groups was conducted to explore the singular effect. The effect of age groups on the Likert scale and neutrosophic scale was statistically significant (respectively, $F = 4.361$, $p < 0.05$; $F=3.272$, $p < 0.05$). In two scales, the difference between the averages in the 45-54 age group and the averages in the over 55 age group was found to be statistically significant ($p < 0.05$). The Likert scale score of clients in the 45-54 age group (Mean = 17.471) is higher than that of clients in the over 55 (Mean = 12.632). Similarly, clients aged between 45 and 54 have a higher neutrosophic scale score (Mean = 2.943) compared to clients aged over 55 (Mean = 1.689).

Table 17. Two-Way ANOVA Results for the Likert and Neutrosophic Scales

Scale	Single and Interaction Effect	Mean Square	F	Significance Level
Likert scale	Gender	10.180	0.810	0.370
	Age	54.870	4.366	0.002
	Gender X Age	6.472	0.515	0.725
Neutrosophic scale	Gender	2.159	1.471	0.227
	Age	4.810	3.277	0.014
	Gender X Age	0.743	0.506	0.731

Two-way ANOVA, two (gender) X five (age), were conducted to explore the individual effects as well as the interaction effects between gender and age. The individual effect of gender ($F = 0.810$, $p > 0.05$) and the interaction effect of gender and age ($F = 0.515$, $p > 0.05$) on the Likert scale were statistically insignificant. However, the single effect of age on the Likert scale was significant ($F =$

4.366, $p < 0.05$). A statistically significant difference was found between the averages of clients in the 45-54 age group and those in the over 55 age group ($p < 0.05$). While clients in the 45-54 age group exhibited the highest Likert scale scores, clients in the over 55 age group demonstrated the lowest Likert scale scores.

Similarly, the single effects of gender ($F = 1.471$, $p > 0.05$) and the interaction between gender and age ($F = 0.506$, $p > 0.05$) on the Neutrosophic scale were not statistically significant. However, the individual effect of the age group on the Neutrosophic scale was statistically significant ($F = 3.277$, $p < 0.05$). Furthermore, there was a significantly difference in the average scores between clients aged 45-54 and those over 55 ($p < 0.05$). The neutrosophic scale score of the clients in 45-54 age group (Mean = 2.943) was higher than the client in 55 over age group (Mean = 1.689). According to the results of the research, studies examining the possible role of demographic differences in physical environmental quality are very rare. Restaurant responses to the quality of the physical environment and employee reactions may differ according to demographic characteristics.

According to the results of both one-way and two-way ANOVA analyses conducted in this study, it was found that 45-54 and 55+ age groups pay attention to the quality of the physical environment (interior design-decor of the restaurant, music, cleanliness of dining areas and employees) when choosing a restaurant. It has also been observed in the literature that mature customers care more about the quality of the physical environment than younger customers [11]. In another study, it is possible to say that the perception of physical environmental elements increases with the increase in the age of consumers. In addition, it was determined that there was no significant difference between the gender status of the participants and their perception of physical environmental elements [46].

6. Conclusions

This research has conducted astute analyses by employing Exploratory Factor Analysis, correlation analysis, and ANOVA to assess the efficacy of Likert and neutrosophic scales in gauging restaurant patrons' perceptions of the quality of the physical environment. The results of the exploratory factor analysis suggest that a solitary component is sufficient to encompass the responses on both measures, thereby streamlining the process of assessing perceived environmental quality. Moreover, a robust positive correlation is observed between the Likert and neutrosophic scales, which substantiates the reliability and consistency of the data collected per these methodologies. The demographic differences in perceptions were emphasized by the ANOVA results, which revealed that individuals aged 45-54 and 55 above exhibit a notably greater level of concern regarding the physical environment's quality in restaurants. This discovery implies the existence of a demographic niche that restaurant proprietors and managers may be able to target in order to increase client loyalty and satisfaction. On the contrary, the absence of gender disparities in the responses suggests that the significance of environmental quality is consistent for both male and female consumers, thereby bolstering the case for a comprehensive strategy towards environmental enhancements.

The restaurant industry can benefit from the practical implications of these findings. A strategic priority could be the enhancement of the physical environment's quality in order to attract and retain a more mature clientele, who are known to place a high value on this aspect. Potentially, implementing modifications that appeal to this age group will result in increased customer satisfaction and enhanced business performance. In its entirety, this study emphasizes the significance of the physical setting in the context of dining and establishes a rigorous methodological structure for evaluating it through the utilization of Likert and neutrosophic scales.

In a prospective future investigation, our intention is to employ machine learning models for the purpose of forecasting demographic variables, including age, education, marital status, and sex, based on the responses obtained from the classical Likert and Neutrosophic Likert scales. Another potential avenue for future research involves utilizing the recently created RANCOM approach, which specifically targets the assessment of Neutrosophic Likert scale data by experts in various fields [47]. A potential future investigation may involve conducting a comprehensive analysis of the data using various scoring functions and comparing the results with the score function employed in this article.

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