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Research Article

A full factorial experimental design-based approach to determine hotel room pricing: The case of Antalya, Türkiye

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ABSTRACT

A revenue-maximizing strategy is an important part of yield management to maximize the service capacity. Specifically, determining hotel room pricing plays a crucial role in maximizing revenue in a highly competitive environment. Therefore, this study proposed an approach based on full factorial experimental design to analyze the effects of qualitative design factors on hotel room pricing. The aim of this paper is three-fold. First, a factorial design was selected to analyze the effects of the four important qualitative design factors (the customer's evaluation, the number of stars, disabled-friendly, and the free cancellation) on hotel room pricing. Second, an estimated regression function was obtained to determine the estimated hotel pricing. Additionally, a pure integer programming model was proposed to obtain the optimum settings of the four qualitative design factors using the desirability function. Furthermore, a nonlinear integer programming model was presented based on a 2^n factorial design for comparison purposes. Third, a case study was presented to determine hotel room pricing in Antalya, Türkiye. According to the results obtained from the case study, the most important qualitative design factor, among others, is the number of stars. The qualitative factors used in the study explain 60.97% of the variation in hotel room prices. In the presented models, it has been determined that the minimum and maximum room prices should be 35 $ and 404 $, respectively. Also, the minimum and maximum room prices determined in both models were consistent, and the optimum results were confirmed. The findings obtained in the study can guide hotel managers in determining appropriate hotel room prices.

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INTRODUCTION

Service systems play an essential role in meeting the customers' intangible experiences. According to the World Tourism Organization (WTO) and the Turkish Statistical Institute (TURKSTAT), tourism is a significant service system and has grown nowadays [1]. With the growth of tourism, there has been an increase in the number of hotels, apartments, and boutique businesses in Türkiye. A hotel's pricing policy is essential to increase its profit and

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sustainability in the highly competitive business environment. Therefore, revenue management techniques are used to maximize income while allocating limited resources within the business to different customer profiles [2, 3]. In addition, revenue management assesses opportunities against uncertain demand [4]. Customers choose the most suitable hotel based on the criteria using travel agencies or commercial websites while analyzing the price and hotel services. This price-performance analysis is expressed as perceived value by marketers [5, 6]. A linear relationship between the price and the perceived value of the hotel by the customer is accepted. However, customer behavior should be analyzed to determine the hotel's price.

Hotel choices of customers are related to their consumption behaviors and include many different criteria [5, 7]. Some of the criteria that people pay attention to when choosing a hotel are as follows: (1) Hotel room price (per night), (2) Hotel location, (3) Ease of reservation and free cancellation, (4) Number of stars, (5) Room type, (6) Customer evaluation, (7) Hotel amenities, such as wi-fi, breakfast, cleaning, disabled, dinner, and so on [8-12].

Hotel managers determine a room price according to the above criteria. Indeed, it is critical to specify the right pricing policy for a hotel's success [13]. It is generally believed that customers must pay high room prices to meet the many expectations and considerations. Actually, the room price depends on the customers' demand. It is essential to examine the pricing policies of competing hotels, demand, and specified criteria when determining the room price of a hotel. Therefore, hotel managers should keep their pricing policies based on a dynamic structure. Additionally, pricing policies are affected by the hotel's market share and size, in other words, the number of stars. For this reason, hotel sizes are evaluated under specific categories to determine the right pricing policy. Five-four-star hotels are reviewed in the first category, and other hotels are in the second category [13, 14].

Nowadays, hotel reservations have been made using online environments, and there are many websites to make reservations. That is why an online hotel reservation site is suitable for collecting the data. This study aims to determine the room pricing policy based on the hotel features of Antalya, which has the highest number of hotels in terms of bed capacity and is a frequent destination in Türkiye.

There are three main contributions to this paper. First of all, the four qualitative design factors are determined as follows: (1) the customer's evaluation, (2) the number of stars, (3) the disabled-friendly, and (4) the free cancellation. A full factorial design is chosen to examine the effects of hotel room pricing when using the four qualitative design factors. Second of all, the estimated hotel pricing is determined. Also, a pure integer programming model is presented with the desirability function to find the optimum settings of the four qualitative design factors. Besides, a nonlinear integer programming model is offered based on a 2^n factorial design to compare the optimization results. Finally, a case study is conducted for the first time in the literature to specify hotel room pricing in Antalya, Türkiye, using the proposed methodology.

The remainder of this paper is organized as follows. A literature review of the relevant studies conducted is given. Then, the methodology used is presented. Next, a case study of Antalya, Türkiye, is undertaken. Further, the results and discussions are provided. Finally, conclusions and future research work are drawn, respectively.

Literature Review

In the literature, a limited number of studies on hotel room pricing mostly used the hedonic price model [15-19]. Although there are experimental design studies in addition to the hedonic price model in the tourism sector [20-24], to the best of the authors' knowledge, there is no experimental design study in which qualitative factors are used to determine hotel room prices. The literature studies are mostly on hotel room reservations or hotel selection problems. Different methods, such as multi-criteria decision-making, fuzzy multi-criteria decision-making, factorial design, and fuzzy logic, are used to solve these problems. Table 1 summarizes the related research works.

MATERIALS AND METHODS

According to the literature research, a full factorial experimental design that analyzes the effects of qualitative design factors on hotel room pricing has not been studied before. For this reason, the flow chart of the room price determination methodology was suggested in Figure 1. As seen in Figure 1, the methodology consists of 5 stages: (i) Determination of the problem, determination of the data parameters and data collection, (ii) Full factorial experimental design, (iii) Obtaining an estimated regression function to determine hotel pricing, (iv) optimization phase, and (v) comparison and verification phase.

This section consists of three subsections. First, a 2^n factorial design with qualitative data is presented on how to build a design matrix for the experiments. Second, a pure integer programming model with the desirability function is developed to find the optimum settings of the four qualitative design factors. Third, a nonlinear integer programming model based on a 2^n factorial design for qualitative data is also presented for comparison and verification purposes.

2^n Factorial Design for Qualitative Data

Experimental studies are an important way to discover how systems work. An experimental design consists of planned trials to understand the source of change in a process under certain assumptions [38, 39]. A traditional experimental design may be divided into three categories: full factorial, fraction factorial, and response surface designs. The 2^n experimental design is a special kind of full

Table 1. The related research works for the hotel room or hotel selection problems

Studied By	Method	Application Area	Decision
Ngai and Wat [25]	Fuzzy Logic	Survey	Hotel Selection
Chen, Schwartz [26]	2 × 2 Experimental Design	Survey Applied at Midwest (USA) University	Hotel Room Reservation
Huertas-Garcia, Laguna García [5]	Fractional And Full Factorial Experiment Design	Travel Agent Brochure	Hotel Room Reservation
Casalo, Flavian [27]	2 × 2 Experimental Design	Tripadvisor.com	Number of Reservations
Zaman, Botti [10]	Multi-Criteria Decision Analysis	Tripadvisor.com	Hotel Selection
Masiero, Pan [28]	Experiment Design	Survey of customers applied at a hotel in Hong Kong	Hotel Room Selection
Park, Ha [29]	Factorial Experiment Design, Three-Way Anova	Hotel Website Surveymonkey.com	Hotel Room Reservation
Gavilan, Avello [30]	Full Factorial Experiment Design	Booking.com Tripadvisor.com	Hotel Room Reservation
Vinzenz [31]	3 × 2 × 2 Experimental Design	Survey	Hotel Room Reservation Decision
Kwok and Lau [32]	TOPSIS	Hotels.com	Hotel Selection
Liang, Liu [33]	DL-VIKOR	Tripadvisor.com	Hotel Selection
Ulucan [34]	Fuzzy TOPSIS	Hotel Investors	Hotel Site Selection
Dogan and Erdogan [35]	2 × 2 Experimental Design	Hotel Advertisements	Hotel Room Reservation Decision
Kim, Jang [17]	Hedonic Price Model	Chicago	Hotel Room Price
Wang, Wang [36]	A Cloud-Based Multi-Criteria Group Decision Support Model	Tripadvisor.com	Hotel Selection
Guo and Li [37]	Two 2 × 2 Factorial Design Experiments	Survey	Hotel Room Reservation Decision
Arzaghi, Genc [16]	Hedonic Price Model	Booking.com	Hotel Room Price

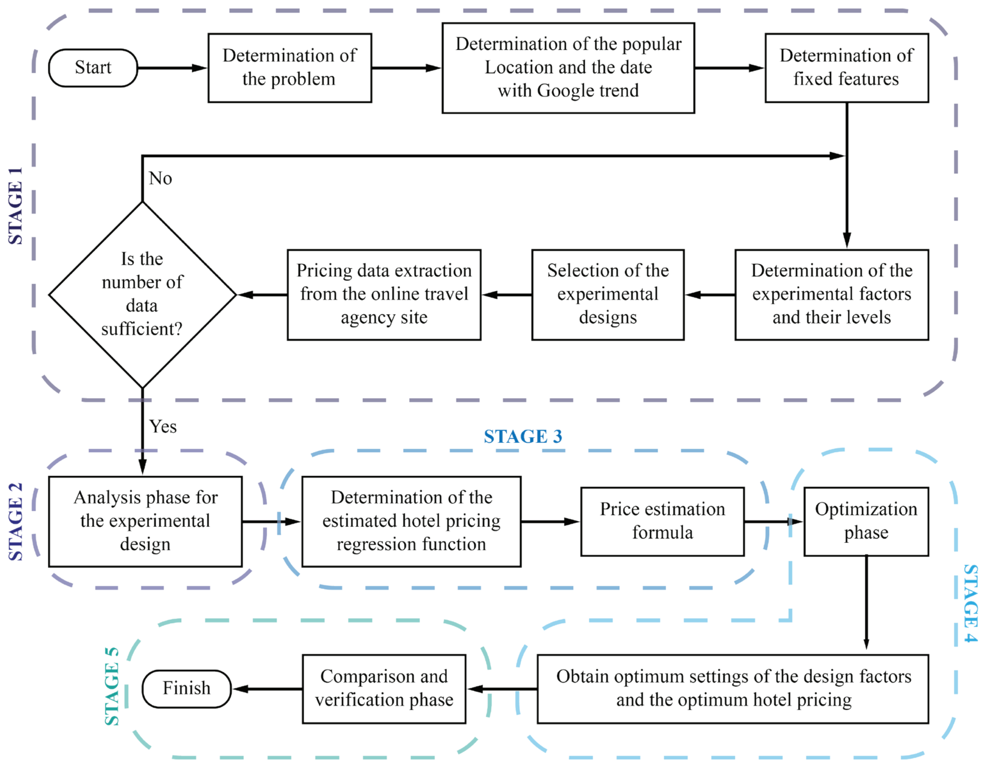

Figure 1. The flow chart of the room price determination methodology.

factorial experimental design, including the main effects of n factors and their interactions with each other [40].

The experiments to be carried out in the experimental design are of two types: field experiments and laboratory experiments. When the types of experiments are adapted according to the field of social sciences, field experiments include survey studies. Laboratory experiments include experiments using data obtained from websites. Design factors created according to the type of experiment performed may be quantitative or qualitative [38, 41-43]. This study used completely qualitative design factors to analyze hotel room pricing. The main and interaction effects of the design factors on hotel room pricing were analyzed, and a pricing formula was obtained.

In this paper, the experimental runs were conducted as follows: (1) Price data for four qualitative design factors was collected. Each experimental run was obtained from the website of a travel agency and replicated three times. (2) The Main and interaction effects of each qualitative design factor are obtained. (3) An estimated response function is obtained to determine the appropriate pricing policy while maximizing profits. In addition, support was provided in determining hotel room prices in line with customers' needs and expectations.

The estimated hotel pricing function is calculated by using the least square method and obtained as follows:

$$\mu(\text{Price}) = \beta_0 + \sum_{i=1}^{4} \beta_i x_i + \sum_{i<j=2} \sum_{i=1}^{4} \beta_{ij} x_i x_j + \sum_{j<k=2} \sum_{i<j=2} \sum_{i=1}^{4} \beta_{ijk} x_i x_j x_k + \beta_{ijkm} x_i x_j x_k x_m \quad (1)$$

where μ(price) average price, βs represent regression coefficients, x_1=A (the first qualitative design factor), x_2=B (the second qualitative design factor), x_3=C (the third qualitative design factor), and x_4=D (the fourth qualitative design factor).

A pure integer programming model with the desirability function

The optimization step is important to obtain the optimum settings of the four qualitative design factors. Thus, the pure integer programming model with the desirability function is proposed. Derringer and Suich [44] presented the concept of the desirability function. The aim of the proposed optimization model is to maximize the desirability of the response where all design factors are qualitative. The proposed model is subject to constraints. The boundary requirements should be defined where the low and high levels of the 2^n experimental design. The proposed pure integer programming model with the desirability function is denoted as follows:

maximize $d_{hrp}(\mu(\text{Price}))^{\frac{1}{2}}$
subject to $-1 \le x_i \le +1$ $(i = 1,2,3,4)$ and integers
where

$$d_{hrp}(\mu(\text{Price})) = \begin{cases} 0, \mu(\text{Price}) < L \\ \left(\frac{\mu(\text{Price}) - L}{T - L}\right), L \le \mu(\text{Price}) \le T, \\ 1, \mu(\text{Price}) > L \end{cases} \quad (2)$$

Note that $d_{hrp}(\mu(\text{Price}))$ is the desirability function of the hotel room pricing. x_i represents the lower (-1) and upper (+1) limits of four qualitative design factors. Then, T and L denote the lower limit and the specified target values, respectively. The value of the $d_{hrp}(\mu(\text{Price}))$ is between 0 and 1. A value of 1 indicates that the situation has reached ideality, and a value of 0 indicates that the answers are not within acceptable limits. In addition, the response status is maximum if the response is between the lower limit and the specified target [44].

A nonlinear integer programming model based on a 2^n factorial design for qualitative data

Nonlinear integer programming (NLIP) combines integer programming and nonlinear optimization techniques [45]. Unlike a linear programming model, the objective function or constraints in NLIP models contain nonlinear functions with integer decision variables.

The purpose of the proposed NLIP model in this study is to maximize the hotel room price subject to the boundary requirements. Factor levels in the experimental design were considered boundary constraints that denote a feasible solution space. Equation (3) shows the objective function of the proposed NLIP model based on a 2^n factorial design for qualitative data, and Equations (4-7) show the boundary constraints. The decision variables, objective function, and boundary constraints are denoted as follows:

Decision Variables:
x_1: Level of Number of Stars
x_2: Level of Customer Evaluation
x_3: Level of Disabled
x_4: Level of Free Cancellation

Objective Function:

$$\max\ Z = \mu(\text{Price})$$
$$\Rightarrow \max\ Z = \beta_0 + \sum_{i=1}^{4} \beta_i x_i + \sum_{i<j=2} \sum_{i=1}^{4} \beta_{ij} x_i x_j + \sum_{j<k=2} \sum_{i<j=2} \sum_{i=1}^{4} \beta_{ijk} x_i x_j x_k + \beta_{ijkm} x_i x_j x_k x_m \quad (3)$$

Boundary Constraints:
$-1 \le x_1 \le 1$ and integer (4)
$-1 \le x_2 \le 1$ and integer (5)
$-1 \le x_3 \le 1$ and integer (6)
$-1 \le x_4 \le 1$ and integer (7)

Notice that a comparison and verification study is conducted between a pure integer programming model with the desirability function and a nonlinear integer programming model based on a 2^n factorial design for qualitative data.

Table 2. Specified design factors and their levels

Design factor	Levels	
	Low level	High level
Number of Stars (A)	<4	≥4
Customer Evaluation (B)	<4.5	≥4.5
Disabled (C)	No	Yes
Free Cancellation (D)	No	Yes

The Case Study of Antalya, Türkiye

According to the literature, there are some parameters that are effective in determining the price of a hotel room. These parameters are location, reservation period, number of people, room type, number of stars, customer evaluation, free cancellation option, and disability status. In the study, location, reservation period, the number of people, and room type were assumed to be fixed. According to the Turkish Culture and Tourism Ministry, Antalya, which is an attractive natural and historical place, is the province with the highest number of hotels in terms of bed capacity and number [46]. For this reason, Antalya was selected as the location, and data from hotels close to central regions were used. Hotels close to the main areas were chosen because people are more interested in hotels in major regions. According to the search made on Google Trend on December 14, 2021, the most hotel searches in Türkiye are between 16-23 July. According to the searches, customers' reservation period covers a one-week holiday. Therefore, the reservation period in this study covers July 16-23. Also, room type was taken as the standard for average pricing and experimental replicates. This paper considered a room for two adults because the hotels apply different prices according to the age of the child customers. The room price was accepted as the response variable.

Data were obtained manually from "trivago.com," a hotel comparison engine for accommodation rates offered by many online booking sites. From "trivago.com," customers can see all prices offered for the same hotel room on other sites, from minimum to maximum. Thus, they can make a reservation at the minimum price when booking. There is more than one hotel on the site with the same conditions. In this way, the experiment and study repetition is not biased. The collected data can be validated through hotel prices available on "trivago.com" on December 14, 2021. Except for the parameters considered constant, the design factors and levels specified according to the literature are shown in Table 2. It should be noted that based on the methodology given in Fig. 1, experimental factors were selected according to data sufficiency.

As seen in Table 2, four qualitative factors under two levels were discussed in this study. When considering the hotel standards, hotels were evaluated in two types: hotels with four stars and above and hotels with below four stars. On "trivago.com," customer evaluations are made on a scale of 1-5. Customer evaluations are generally higher for hotels with a higher number of stars. In order to collect sufficient data, the evaluation rating was determined as 4.5 [47]. Hotels may or may not have "disabled" and "free cancellation"

Table 3. The collected data of the hotel room pricing using the 2^n factorial design

	Experimental Factor				Price ($)		
Run	A	B	C	D	I	II	III
1	>=4	>=4.5	Yes	No	267.813	606.218	267.813
2	>=4	<4.5	No	Yes	83.258	99.634	109.729
3	<4	<4.5	No	No	55.523	39.064	38.698
4	<4	>=4.5	No	Yes	202.634	76.811	81.931
5	<4	<4.5	Yes	No	35.113	42.648	90.856
6	<4	>=4.5	Yes	No	79.298	39.649	51.207
7	>=4	<4.5	No	No	130.724	317.484	175.128
8	<4	>=4.5	No	No	126.774	135.845	49.232
9	<4	>=4.5	Yes	Yes	428.676	105.633	104.974
10	>=4	>=4.5	No	Yes	365.618	234.967	197.879
11	>=4	<4.5	Yes	Yes	162.546	246.452	504.755
12	>=4	>=4.5	Yes	Yes	510.607	447.696	570.154
13	>=4	>=4.5	No	No	224.433	313.606	136.357
14	<4	<4.5	Yes	Yes	114.996	121.873	48.427
15	>=4	<4.5	Yes	No	279.298	261.887	141.331
16	<4	<4.5	No	Yes	52.890	73.153	74.323

A: Number of stars; B: Customer Evaluation; C: Disabled; D: Free Cancellation.

conditions. A total of 16 (2^4) different combinations were conducted according to the 2^n factorial design. Three replications were made for each combination of experiments, and 48 results were obtained according to the principle of randomness. The alpha value (α) was specified as 0.05 in statistical tests. In each repetition, the room prices of different hotels were accepted, and the collected data regarding hotel room prices are shown in Table 3. The results obtained for three repetitions are given in the "Price" section.

RESULTS AND DISCUSSION

The data analysis was performed using the demo version of Minitab19 in this study. The data analysis was carried out in two steps. In the first step, an analysis of variance was conducted, and the results of the analysis of variance of main effects and interactions are shown in Table 4.

The F test was used to test a null hypothesis assuming that the main effects and interactions are equal to zero. Main effects and interactions with p-values less than 0.05 indicate that hotel room price is primarily determined by the number of stars (A), customer evaluation (B), disabled (C), and "the number of stars * disabled" (A*C) (p_A <0.001; p_B=0.002; p_C=0.003; p_{A*C} =0.022).

In the second step, statistically insignificant sources were neglected, and the experimental results were re-analyzed. Table 5 shows the estimated effects and coefficients of the reduced model. According to the T-tests, the main effects of A, B, and C are significant at the 1% level, and the interaction A*C is significant at the 5% level. The number

Table 4. Anova results

Source	DF	Adj SS	Adj MS	F-value	p-value
Linear	4	634,064.000	158,516.000	16.900	**0.000**
A	1	400,615.000	400,615.000	42.700	**0.000**
B	1	112,718.000	112,718.000	12.020	**0.002**
C	1	94,895.000	94,895.000	10.120	**0.003**
D	1	25,836.000	25,836.000	2.750	0.107
2-Way Interactions	6	134,170.000	22,362.000	2.380	0.051
A*B	1	18,246.000	18,246.000	1.940	0.173
A*C	1	54,762.000	54,762.000	5.840	**0.022**
A*D	1	1,767.000	1,767.000	0.190	0.667
B*C	1	5,920.000	5,920.000	0.630	0.433
B*D	1	18,607.000	18,607.000	1.980	0.169
C*D	1	34,868.000	34,868.000	3.720	0.063
3-Way Interactions	4	9,545.000	2,386.000	0.250	0.905
A*B*C	1	5,233.000	5,233.000	0.560	0.461
A*B*D	1	1,579.000	1,579.000	0.170	0.684
A*C*D	1	2,630.000	2,630.000	0.280	0.600
B*C*D	1	104.000	104.000	0.010	0.917
4-Way Interaction	1	9,336.000	9,336.000	1.000	0.326
A*B*C*D	1	9,336.000	9,336.000	1.000	0.326
Error	32	300,205.000	9,381.000	-	-
Total	47	1,087,321.000	-	-	-

A: Number of Stars; B: Customer Evaluation; C: Disabled; D: Free Cancellation, DF: Degree of Freedom, Adj SS:Adjusted Sum of Squares, Adj MS: Adjusted Mean of Squares, F-Value: Fisher, p-value: Probability Statistic

Table 5. Estimated coefficients of the reduced model

Term	Effect	Coef	SE Coef	T-value	P-value
Constant	-	186.000	14.300	12.970	**0.000**
A	182.700	91.400	14.300	6.370	**0.000**
B	96.900	48.500	14.300	3.380	**0.002**
C	88.900	44.500	14.300	3.100	**0.003**
A*C	67.600	33.800	14.300	2.360	**0.022**

A: Number of stars; B: Customer Evaluation; C: Disabled; S = 99.3386, R^2 = 60.97%, R^2 (pred.) = 51.37% and R^2 (adj.) = 51.37%

of stars (A) is the most effective factor on hotel room price since it has the highest effect value ($Effect_A$=182.700). Similar to this study, Israeli [48] suggests that the number of stars is the most effective factor in determining the hotel price.

According to the number of stars*disabled interaction, the hotel will give the highest room price if the number of stars is four or more and the hotel is disabled-friendly. There may be some reasons why only this interaction is significant among the others. The World Health Organization (WHO) states that 15% of the world's population experiences different levels of disability and these disadvantaged individuals constitute 7-8% of the tourism market [49]. With the increase in disadvantaged individuals in society, the demand for hotels with disabled-friendly features is also increasing. When demand increases, price increases if all other things remain the same. As a result, an increase in the number of stars has a significant positive effect on hotel room prices when the hotel is disabled-friendly.

The coefficient value in Table 5 shows the change that will occur in the price if the factors that are found to be significant increase by one unit. Equation (8) shows the regression model obtained from the case study results. When the values suitable for the A, B, C, and A*C factors are written in Equation (8), the result will show the price of the hotel for one night. Together with this formula, hotel managers will be able to determine the room price that can optimize their investments according to the features of the hotel rooms.

$$\mu(\text{Price}) = 186 + 91.4*A+48.5*B+44.5*C+33.8*A*C \quad (8)$$

According to the determined room price, the number of stars (A) is the most influential factor in room pricing. According to the analysis, 60.97% of the variation in room pricing is explained by design factors in the 2^n experimental design. Residual (39.03%) originates from other factors not included in the experimental study. The multivariate graph in Figure 2 shows how the design factors affect each other in the experimental design. For example, in the case of disabled guests for four or more-star hotels, the room price increases per night as the customer rating increases. Similarly, in hotels with below four stars, if the hotel does not have a disabled-friendly feature, the hotel room price decreases as the customer evaluation rating decreases.

This study aims to select the optimum settings for the four qualitative design factors to maximize the room rate. For this particular reason, the proposed optimization model in (2) was solved for the hotel room pricing, and the results are given in Table 6.

Table 6 gives optimal prices and d_{hrp} values for certain price ranges. According to the obtained results, the lowest room price was found to be \$35. The d_{hrp} value for \$35 was found to be 0.999. This value shows maximum acceptability. The highest room price was found to be \$404. The lowest d_{hrp} value was found to be 0.646 for \$404.

In addition to the pure integer programming model, the NLIP model was also proposed in this study. The proposed NLIP model was solved with the help of the GAMS solver. The maximum room price was achieved as \$404.

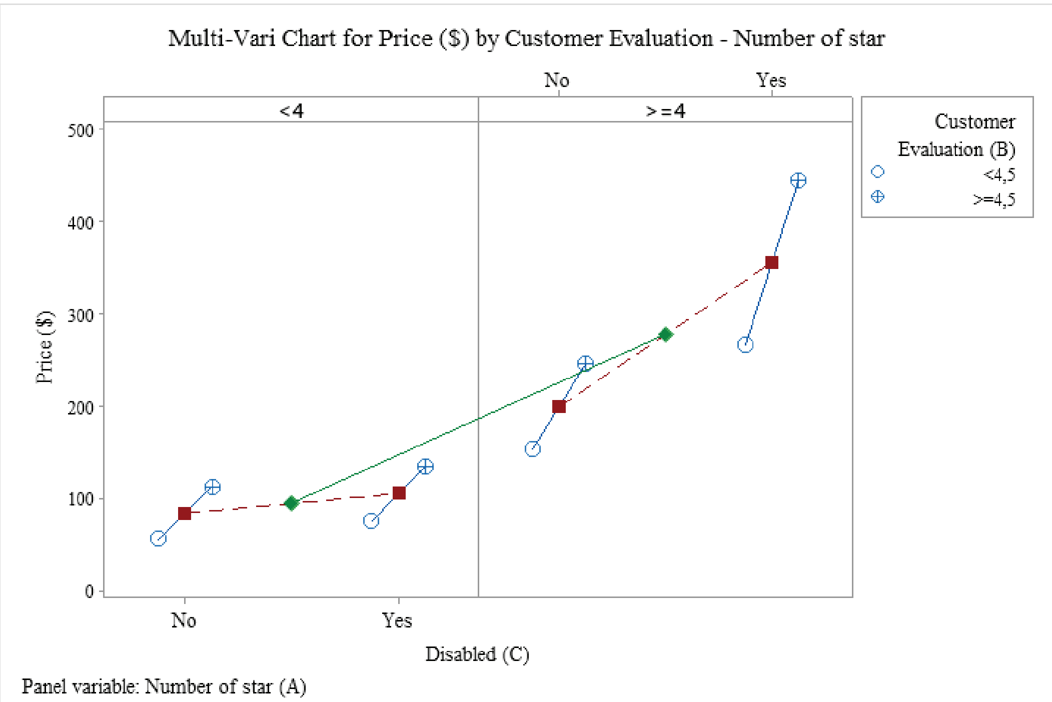

Figure 2. Multivariate chart for hotel room pricing.

Table 6. Optimization results from the proposed model in Equation (2)

Range	Number of stars	Customer evaluation	Disabled	d_{hrp}	Price
Min	<4	<4.5	No	0.999	35.447
36-60	<4	<4.5	Yes	0.872	56.820
61-135	<4	≥4.5	No	0.974	132.366
136-151	≥4	<4.5	No	0.997	150.608
152-177	<4	≥4.5	Yes	0.836	153.738
178-272	≥4	≥4.5	No	0.897	247.527
273-362	≥4	<4.5	Yes	0.832	307.088
363-Max	≥4	≥4.5	Yes	0.646	404.007

The results in both models are the same; therefore, the optimization results are verified.

When other studies in the literature are examined, it has been observed that the most important factors when determining a hotel room are the number of stars and the customer's evaluation [48, 50-53]. Among these studies, [50, 53] found customer evaluation to be more important. Similarly, other studies in the literature find the number of stars more important than the customer's evaluation [48, 51, 52]. In this study, both factors were analyzed, and the number of stars was found to have a more significant effect. However, although not as important as the number of stars, customer evaluations were also found to be important. Additionally, the disabled-friendly factor, which was not analyzed in studies in the literature, was evaluated as a factor in this study. Since disadvantaged individuals demand more travel and accommodation today, the disabled factor was included in the study and was statistically significant. The results obtained using the specified design factors are consistent with the existing literature.

CONCLUSION

Experimental design reveals the relationship between the inputs in a process and the output of the process. There are inputs to optimize the output variable. It can be used with qualitative or quantitative data. The use of entirely qualitative data in this study separates the study from other studies. The primary purpose of this study is to determine the room prices so that customers can make price-performance analyses and hotel managers can earn maximum profit.

This study presents an experimental approach to the hotel room pricing problem using actual data from an online travel agency. The 2^4 factorial design was used for this particular purpose, and three replications were made for each experimental run. Then, a proposed pure integer programming model with the desirability function is presented to obtain the optimum level settings. Also, a nonlinear integer programming model is developed associated with a 2^n factorial design for qualitative data to compare and verify optimization results. According to the analysis results, the room prices of the hotels with more than four stars, disabled, and have a rating of more than 4.5 according to customer evaluation are at the highest level compared to others. The price is around $404 for these levels; however, the d_{hrp} value is minimum for this price. On the contrary, the d_{hrp} value is higher when the price ($35) is minimum. Increasing the d_{hrp} value increases acceptability. Therefore, the low prices obtained in this study are more acceptable than the high prices.

According to the results of this study, the rate of explaining the room price of the model established is 60.97%. The number of stars in the model is more effective on the room price than other factors. However, the factors used are insufficient to determine the room price exactly.

FUTURE STUDIES

The location was fixed in the study, and suggestions were presented for this situation. However, a location selection problem could be added to further research. For this particular purpose, multi-criteria decision-making (MCDM) techniques could be combined with the design of experiments. This kind of study could provide a comprehensive analysis that includes various factors when determining hotel locations. For example, considering design factors, such as regional demand, tourist attraction status, and transportation, may be important for the hotel location selection problem.

Additionally, the inclusion of both quantitative and qualitative design factors not addressed in this paper could be a further research topic. Particularly, analyses using quantitative design factors (room size, hotel service quality index, etc.) could help explain the effects on hotel room pricing in more detail. Thus, future studies could evaluate design factors more comprehensively.

Finally, demand-related constraints could be added to NLIP in future studies. Hence, new strategies for determining the hotel room price could be investigated according to the customers' demand for the hotel.

AUTHORSHIP CONTRIBUTIONS

Authors equally contributed to this work.

DATA AVAILABILITY STATEMENT

The authors confirm that the data that supports the findings of this study are available within the article. Raw data that support the finding of this study are available from the corresponding author, upon reasonable request.

CONFLICT OF INTEREST

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

ETHICS

There are no ethical issues with the publication of this manuscript.

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