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Enhancing customer satisfaction towards the service quality of Soekarno-Hatta International Airport using servqual and binary logistic regression

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ABSTRACT

The world is experiencing rapid change, leading to transformations in human lifestyles that necessitate adaptation. However, the aviation industry appears to have reached a point of stagnation. Soekarno-Hatta International Airport must adapt to the new needs and demands of passengers by implementing necessary changes and incorporating the latest available technologies. To gain a deeper understanding of passenger satisfaction regarding the service quality at Soekarno-Hatta International Airport, the SERVQUAL method and Binary Logistic Regression Analysis were employed. Both methods aim to identify services that has a significant impact and determine the relative influence of these services on the overall service quality at Soekarno-Hatta International Airport. The results of the SERVQUAL method in this study indicate that there are 14 services at Soekarno-Hatta International Airport that do not meet passenger satisfaction standards, with a need for particular attention to the reliability dimension. Subsequently, the Binary Logistic Regression analysis results indicate that only parking price and ambience significantly influence passenger satisfaction, with the likelihood of increasing satisfaction being 1.7732783 and 2.0773711 times respectively. The focus should be placed on improving operational accuracy through stringent Standard Operating Procedures (SOPs) and comprehensive staff training, reducing supplementary expenses like toll charges, expanding parking facilities, and optimizing parking flow, improving lighting, customer engagement, and noise control measures.

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1. INTRODUCTION

Rapid globalization has transformed human lifestyles and heightened vulnerability across industries, as evidenced by the recent COVID-19 pandemic. Data provided by Flightradar24, ICAO, IATA, and EUROCONTROL, underscores the pandemic's profound impact on global aviation, resulting in rating downgrades. Despite reopening efforts, the recovery has been slower than anticipated, highlighting the necessity for assessments and improvements [1].

With the global landscape evolving and following an analysis of responses from 33 individuals regarding their satisfaction at the airport, it is revealed that 70% of the respondents express contentment, while 30% identify areas for improvement. This underscores the necessity for further research to prioritize enhancement and enhance overall customer satisfaction, as well as to adapt to the current needs of customers. Evaluating the quality of services at the airport becomes imperative to meet the evolving demands of customers, with a specific focus on enhancing satisfaction with service quality aligned with current trends and the adoption of cutting-edge technology [2].

Recent research on airport service quality has utilized various methodologies, including Exploratory Factor Analysis (EFA) and ANOVA, to assess pre-pandemic airport service quality criteria in Europe [3]. EFA and Ordinal Logistic Regression have been employed to identify aspects of airport service quality, taking into consideration customer characteristics [4]. Confirmatory Factor Analyses (CFA) have been utilized to explore the relationships among airport service quality, airport selection, and customer destinations. Further investigations are planned to comprehend post-pandemic customer needs and identify key service quality aspects for enhancing overall service quality at Soekarno-Hatta International Airport [5]. Previous studies have also employed SERVQUAL, which facilitates the assessment and diagnosis of strengths and weaknesses in service attributes, providing a deeper insight into customers' perspectives regarding these service attributes. [6]. In the context of predictive analysis, Artificial Neural Networks (ANN) stand out as a valuable method for forecasting unstable parameters, even in the absence of a precise understanding of variable relationships. Nonetheless, ANN effectiveness relies heavily on the availability of a sizable experimental database [7]. Conversely, Decision Tree Analysis emerges as a straightforward and widely adopted alternative, despite its susceptibility to overfitting and relatively lower accuracy when compared to ANN [8]. Previous research has also utilized Binary Logistic Regression Analysis to predict events, such as customer satisfaction. This method offers insights into parameter weights and sensitivity analysis of input variables without necessitating as large a database, while also demonstrating resilience against overfitting [9].

Therefore, this research, which utilized the SERVQUAL method and Binary Logistic Regression Analysis at Soekarno-Hatta International Airport, aimed to enhance passenger satisfaction with service quality. The SERVQUAL method is utilized to assess customer satisfaction by categorizing service attributes into five main dimensions, to see which dimensions still have issues or need attention. Meanwhile, Binary Logistic Regression is utilized to identify services that have a significant impact on satisfaction, and to calculate their relative influence to predict customer satisfaction. This research is anticipated to provide a comprehensive understanding of customer needs and has the potential to enhance satisfaction with services at Soekarno-Hatta International Airport, benefiting airport management, airlines, and other stakeholders in the Indonesian aviation industry.

2. MATERIALS AND METHODS

This research commences with an extensive review of literature focused on enhancing quality, service, and the overall performance of Soekarno-Hatta International Airport. Meeting customer expectations necessitates continuous efforts by organizations to deliver optimal quality through sustained improvement initiatives, as highlighted in previous studies [10]. The pivotal role of service in the comprehensive operations of an organization is underscored in the literature [11]. Notably, the quality annual count of customers utilizing Soekarno-Hatta International Airport demonstrates a consistent upward trend, emphasizing the airport's significance and the need for ongoing improvements [12].

As mentioned in the introduction, the aviation sector has faced stagnation amidst the backdrop of globalization. Consequently, Soekarno-Hatta International Airport must adapt to the evolving needs of customers. This study utilizes SERVQUAL and Binary Logistic Regression Analysis to enhance satisfaction with service quality at Soekarno-Hatta International Airport. The objectives of this research are anticipated to be achieved through the pursuit of several outlined goals:

1. Identify services at Soekarno-Hatta International Airport that fail to meet satisfaction standards
2. Identify services that have a significant impact on the satisfaction of service quality at Soekarno-Hatta International Airport.
3. Design and evaluate a Binary Logistic Regression model to measure the accuracy of predicting customer satisfaction regarding service quality at Soekarno-Hatta International Airport.

4. Assess the relative influence level of services that have a significant impact on the satisfaction of service quality at Soekarno-Hatta International Airport.
5. Develop improvement proposals to enhance customer satisfaction with service quality at Soekarno-Hatta International Airport.

The primary focus of data collection lies in acquiring information through Questionnaire 1. The construction of Questionnaire 1 adheres to the guidelines outlined in Airport Service Quality (ASQ) [13]. ASQ provides various research tools and management information to further understand customers' perceptions of airport service product [14]. To delve deeper into customer satisfaction at Soekarno-Hatta International Airport, the SERVQUAL method was employed to classify ASQ service attribute questions.
SERVQUAL encompasses five fundamental dimensions [6]:

1. Tangibles: The physical aspects of Soekarno-Hatta International Airport's operation.
2. Reliability: Assesses Soekarno-Hatta International Airport's capability to deliver services accurately and satisfactorily.
3. Responsiveness: Soekarno-Hatta International Airport's promptness in responding to customers requests.
4. Assurance: Soekarno-Hatta International Airport's competence and its employees' knowledge in providing comfort and security for users.
5. Empathy: Soekarno-Hatta International Airport's ability to empathize with its users.

Before distributing the questionnaire to customers, it is crucial to draft a sampling plan. The sample size was calculated using Slovin's Formula, as this method allows for determining the sample size with the desired level of accuracy.The number of customers is assumed based on May 2023 data obtained from PT Angkasa Pura II, with a confidence level of 90% and a tolerance error of 10%. Slovin's Formula is expressed as follows [15]:

$$n = \frac{N}{1 + Ne^2} \tag{1}$$

where,
n = sample size
N = population size
e = margin of error

After determining the sampling plan, the questionnaire is distributed, and the sample is taken using simple random sampling. This method follows the principle that each sample in a population has an equal chance of being selected [16]. The distribution process of Questionnaire 1 is carried out online through the Google Form platform until the minimum required sample size is achieved.

The characteristics of respondents in Questionnaire 1 are presented in Table 1. The majority of respondents are female (69%), aged between 18 and 25 (72%). More than half of the respondents have higher education (70%), almost all are Indonesian citizens (97%), and reside in Indonesia (93%). Nearly half of the respondents (42%) last used Soekarno-Hatta International Airport 0-3 months ago. More than half use the airport 0-2 times a year. The majority (84%) intentionally choose to use the airport.

Table 1. Characteristics of questionnaire 1 respondents

Characteristic	Category	Frequency	Percentage
Age	18-25	72	72%
	26-40	4	4%
	41-65	22	22%
	> 66	2	2%
Gender	Male	31	31%
	Female	69	69%
	Rather Not Say	0	0%
Education	Primary	0	0%
	Secondary	0	0%
	High School	30	30%
	Higher Education	70	70%
Nationality	Indonesian	97	97%

Characteristic	Category	Frequency	Percentage
	Singaporean	0	0%
	Malaysian	1	1%
	Australian	0	0%
	Other	2	2%
Region of Residence	Indonesia	93	93%
	Singapore	3	3%
	Malaysia	1	1%
	Australia	0	0%
	Other	3	3%
The last time the services of the examined airport were used	0 - 3 months ago	42	42%
	3 - 6 months ago	26	26%
	6 - 12 months ago	15	15%
	> 1 year ago	17	17%
Frequency of airport use in a year	0 - 2 times	60	60%
	3 - 4 times	29	29%
	5 - 10 times	8	8%
	> 10 times	3	3%
The main purpose of travelling	Studying	9	9%
	Family Visit	29	29%
	Business	8	8%
	Tourism	50	50%
	Other	4	4%
Travel Companion	Family Visit	64	64%
	Friends	14	14%
	Life Partner	6	6%
	Yourself	14	14%
	Other	2	2%
The most important factor when choosing an airline	Airport Location	28	28%
	Service	61	61%
	Price	7	7%
	Other	4	4%
Is Bandara Internasional Soekarno-Hatta chosen on purpose ?	Yes	84	84%
	No	16	16%

Validity and reliability testing was then conducted on the initial 33 respondents using SPSS version 26.0.0.0 to ensure that the results obtained from the preliminary study can adequately support the urgency of improving the service quality at Soekarno-Hatta Airport. Validity testing verifies that the questionnaire accurately addresses the research variables and objectives. This process utilizes the Pearson Product Moment Correlation method on each SERVQUAL dimension. An element in the instrument is considered valid if the significance value of the Pearson Product Moment Correlation validity test is less than 0.05 [17]. Reliability testing, utilizing the Cronbach's Alpha method, ensures that the questionnaire is consistent and reliable when applied repeatedly to the same sample. The assessment of reliability shows that an alpha value greater than 0.5 indicates acceptability [18].

Twenty-six services, aligned with the ASQ standards used to assess international airports, are employed in this study to evaluate Soekarno-Hatta International Airport as a whole, thus providing a comprehensive overview [13]. This approach allows for a generalized assessment across all terminals, ensuring that the findings represent the airport's overall performance rather than focusing on individual terminals, thereby offering a more holistic understanding of service quality across the entire airport. The twenty-six services are categorized into five main SERVQUAL dimensions, and detailed results of this classification can be found in the attached Table 2.

After reaching the minimum required sample size, the collection of Questionnaire 1 ceased. Only data from the validated and reliable questions were included in the analysis. The average Likert Scale was calculated to assess customer satisfaction with each service. Services with an average rating below 4, or below the satisfaction level, were separated and became the primary focus of further research.

Table 2. SERVQUAL

Dimension	Service	Reference	Dimension	Service	Reference
Tangible	Number of seats at the boarding gates	[19]	Reliability	Passport control time	[19]
	Restaurants	[19]		Security check time	[19]
	Price of goods sold			Check-in time	[19]
	Parking price			Boarding time	[19]
	Clarity of terminal signs	[19]		Baggage claim time	[19]
	Airlines regulations	[20]	Responsiveness	Staff behavior in responding to specific situations	[21]
	Form of boarding	[19]		Staff behavior towards the disabled	[19]
	Accessibility	[21]		Airport information handling	[21]
	Completeness of facilities	[21]		security staff behavior	[21]
	Congestion	[19]	Assurance	Security and privacy measures	[22]
	Cleanliness	[19]		Flight grid	[22]
Empathy	Check-in service staff behavior	[22]		Flight punctuality	[21]
	Boarding service staff behavior	[22]		Ambience	[19]

Next, the processed data was tested to ensure that all assumptions of Binary Logistic Regression were met. One of the assumptions is no perfect multicollinearity, ensuring that independent variables do not have perfect correlation among them. One method to evaluate multicollinearity is Variance Inflation Factor (VIF) [23]. If VIF exceed 5 to 10 and tolerance fall below 0.1 to 0.2, it indicates the presence of multicollinearity [24].

Another assumption, linearity, ensures that independent variables or continuous predictors have a linear relationship with the log-odds of the predicted probabilities for a particular outcome [22]. The Wald statistical test can be employed to test the linearity hypothesis in the logistic regression model, typically conducted at a significance level of 0.05 [25].

If all assumptions are satisfied, the data will be used as input for Binary Logistic Regression Analysis, conducted using RStudio version 23.03.0. The desired outcome is a predictive model to forecast the occurrence or non-occurrence of an event [9]. Another outcome is the probability equation for the occurrence of an event follows the formula [9]:

$$P_{y=1} = \pi = \frac{e^{\propto+\beta X}}{1 + e^{\propto+\beta X}} \tag{2}$$

where,
$P_{y=1}$ = probability of the occurance of an event
$\propto$ = model constant
X = vector of n variables $(X_1, X_2, \dots, X_n)$
β = vector of model regression coefficient $(\beta_1, \beta_2, \dots, \beta_n)$

The probability equation for non-occurrence of an event follows the formula [9]:

$$P_{y=0} = 1 - \pi = \frac{1}{1 + e^{\propto+\beta X}} \tag{3}$$

where,
$P_{y=0}$ = probability of the non-occurance of an event
$\propto$ = model constant
X = vector of n variables $(X_1, X_2, \dots, X_n)$
β = vector of model regression coefficient $(\beta_1, \beta_2, \dots, \beta_n)$

Binary Logistic Regression can also show odds ratio, which is compares the likelihood of an event occurring to the likelihood of it not occurring [26]. The model was evaluated using the F1-score and Area under the Curve (AUC). An increase in the F1-score indicates improved accuracy [27]. It's important to note that the F1-score is limited to a maximum of 1 [28]. Furthermore, an optimal classification should exhibit an AUC value far beyond 0.5. If the AUC value reaches 1, it indicates that the model's accuracy is very high, capable of identifying classes with 100% sensitivity and 100% specificity [20].

For the second data collection, Questionnaire 2 was developed. The construction of Questionnaire 2 is intended to validate and further explore the significant impact of service attributes at Soekarno-Hatta International Airport identified through binary logistic regression analysis. The sampling plan for Questionnaire 2 remains consistent with that of Questionnaire 1. The collection of results from Questionnaire 2 was conducted until the minimum required sample size was achieved, following the established plan to ensure the validity and completeness of the necessary data. The analysis of Questionnaire 2 results involved visualizing the collected data in tabular form, aiming to draw more profound conclusions and confirm service attributes with a significant impact.

The characteristics of respondents for Questionnaire 2 are presented in Table 3, with the majority residing in Indonesia (92%) and a smaller percentage in other places such as Singapore (6%). Furthermore, the majority (84%) utilize the parking facilities at Soekarno-Hatta International Airport 0-2 times a month, primarily for facilitating pick-up and drop-off (62%). Respondents of Questionnaire 2 differ from those of Questionnaire 1. However, employing different respondent groups ensures diverse viewpoints and reduces the risk of bias, potentially yielding more comprehensive and robust findings.

Table 3. Characteristics of questionnaire 2 respondents

Characteristic	Category	Frequency	Percentage
Region of Residence	Indonesia	92	92%
	Singapore	6	6%
	Australia	1	1%
	New Zealand	1	1%
Frequency of parking facilities use in a month	0 - 2 times	83	83%
	3 - 4 times	11	11%
	5 - 10 times	5	5%
	> 10 times	1	1%
The main purpose of using parking facilities	Facilitating pick-up and drop-off at Soekarno-Hatta International Airport	62	62%
	Enabling quick access to theairport terminal	26	26%
	Facilitating private air travel	12	12%

Finally, the Conclusion and Recommendations were formulated. The Conclusion presented essential information regarding customer service satisfaction, the results of the analysis, and the insights gained from this research. Recommendations were crafted to provide guidance on actions or quality improvement steps based on the findings related to customer satisfaction with services at Soekarno-Hatta International Airport.

3. RESULTS AND DISCUSSION

3.1. Introduction Analysis

The open-ended responses from the initial 33 respondents regarding their overall satisfaction with Soekarno-Hatta International Airport are categorized into satisfied and dissatisfied. If respondents indicated that the service quality of Soekarno-Hatta International Airport only reached adequacy or had the potential for improvement, it was categorized as dissatisfied due to perceived areas that needed improvement. Based on the responses, 70% of the respondents expressed satisfaction, while 30% felt dissatisfied. Therefore, these findings indicate there are still potential areas for improvement in various aspects of airport services, serving as the basis for further research to identify necessary improvement priorities and enhance customer satisfaction with the quality of Soekarno-Hatta International Airport services. The questionnaire findings also highlight diverse complaints related to Soekarno-Hatta International Airport, including issues such as discomfort, lack of friendliness and courtesy from staff, system irregularities, failure to meet international standards, limited facilities, and unsatisfactory service.

3.2. Validity Test

The validity test is conducted separately for each of the five SERVQUAL dimensions. This is performed because each dimension reflects specific characteristics or aspects of service quality, each with different evaluation criteria. The method employed for this testing is the Pearson Product Moment Correlation. The results of the validity test can be observed in Table 4.

Table 4. Validity test

Dimension	Service	Validity Test		
		r_{xy}	$r_{(0,05;33)}$	Explanation
Tangible	Number of seats at the boarding gates	0.619	0.344	**valid**
	Restaurants	0.534	0.344	**valid**
	Price of goods sold	0.708	0.344	**valid**
	Parking price	0.589	0.344	**valid**
	Clarity of terminal signs	0.614	0.344	**valid**
	Airlines regulations	0.721	0.344	**valid**
	Form of boarding	0.823	0.344	**valid**
	Accessibility	0.692	0.344	**valid**
	Completeness of facilities	0.71	0. 344	**valid**
	Congestion	0.479	0.344	**valid**
	Cleanliness	0.583	0.344	**valid**
Reliability	Passport control time	0.754	0.344	**valid**
	Security check time	0.757	0.344	**valid**
	Check-in time	0.637	0.344	**valid**
	Boarding time	0.826	0.344	**valid**
	Baggage claim time	0.569	0.344	**valid**
Responsiveness	Staff behavior in responding to specific situations	0.663	0.344	**valid**
	Staff behavior towards the disabled	0.778	0.344	**valid**
	Airport information handling	0.799	0.344	**valid**
	Security staff behavior	0.81	0.344	**valid**
Empathy	Check-in service staff behavior	0.941	0.344	**valid**
	Boarding service staff behavior	0.921	0.344	**valid**
Assurance	Security and privacy measures	0.624	0.344	**valid**
	Flight grid	0.616	0.344	**valid**
	Flight punctuality	0.727	0.344	**valid**
	Ambience	0.763	0.344	**valid**

The correlation coefficient (R) at a significance level of 0.05, with a sample size (n) of 33 respondents, was found to be 0.344. Upon comparing the values of r_{xy} for each service question with the tabled r values, it can be concluded that the r_{xy} values for each service question consistently exceed 0.344. Therefore, it can be inferred that all questions posed in Questionnaire 1 have adequate validity and can be utilized for further data processing.

3.3. Reliability Test

The reliability test is conducted separately for each of the five SERVQUAL dimensions. This is performed because each dimension reflects specific characteristics or aspects of service quality, each with different evaluation criteria. The method employed for this testing is the Cronbach's Alpha. The results of the reliability test can be observed in Table 5. The accepted threshold for alpha is 0.5.

After comparing the values of Cronbach's Alpha for each service question with the alpha threshold, it can be concluded that the Cronbach's Alpha values for each service question consistently exceed 0.5. Therefore, it can be inferred that all questions posed in Questionnaire 1 are reliable and can be used for further data processing.

Table 5. Reliability test

Dimension	Service	Reliability Test		
		Cronbach's Alpha	**Alpha**	**Explanation**
Tangible	Number of seats at the boarding gates	0.744	0.5	**reliable**
	Restaurants	0.746	0.5	**reliable**
	Price of goods sold	0.731	0.5	**reliable**
	Parking price	0.738	0.5	**reliable**
	Clarity of terminal signs	0.738	0.5	**reliable**
	Airlines regulations	0.735	0.5	**reliable**
	Form of boarding	0.728	0.5	**reliable**
	Accessibility	0.734	0.5	**reliable**
	Completeness of facilities	0.736	0.5	**reliable**
	Congestion	0.745	0.5	**reliable**
	Cleanliness	0.739	0.5	**reliable**
Reliability	Passport control time	0.669	0.5	**reliable**
	Security check time	0.674	0.5	**reliable**
	Check-in time	0.74	0.5	**reliable**
	Boarding time	0.63	0.5	**reliable**
	Baggage claim time	0.773	0.5	**reliable**
Responsiveness	Staff behavior in responding to specific situations	0.782	0.5	**reliable**
	Staff behavior towards the disabled	0.764	0.5	**reliable**
	Airport information handling	0.755	0.5	**reliable**
	Security staff behavior	0.749	0.5	**reliable**
Empathy	Check-in service staff behavior	0.849	0.5	**reliable**
	Boarding service staff behavior	0.896	0.5	**reliable**
Assurance	Security and privacy measures	0.754	0.5	**reliable**
	Flight grid	0.754	0.5	**reliable**
	Flight punctuality	0.721	0.5	**reliable**
	Ambience	0.712	0.5	**reliable**

3.4. Questionnaire 1 Data Analysis

With responses from 100 participants through Questionnaire 1, which is the minimum sample collected is determined through the sampling process, the average satisfaction level for each service is then calculated to identify attributes that fall below the satisfaction threshold. The set threshold is 4, aligned with the Likert scale where 1 point indicates complete dissatisfaction, 2 points for dissatisfaction, 3 points for neutrality, 4 points for satisfaction, and 5 points for complete satisfaction. Services with average scores below 4, implying they do not meet the desired satisfaction standard according to customers, are highlighted as the primary focus for improvement. The results of the average satisfaction calculations are presented in Table 6.

Table 6. Questionnaire 1: Data analysis

Dimension	Service	Average	Dimension	Service	Average
Tangible	Number of seats at the boarding gates	4.13	Reliability	Passport control time	**3.79**
	Restaurants	4.08		Security check time	**3.99**
	Price of goods sold	**3.22**		Check-in time	**3.95**
	Parking price	**3.23**		Boarding time	**3.98**
	Clarity of terminal signs	4.05		Baggage claim time	**3.36**
	Airlines regulations	**3.96**	Responsiveness	Staff behavior in responding to specific situations	**3.67**
	Form of boarding	**3.98**		Staff behavior towards the disabled	4.11
	Accessibility	**3.98**		Airport information handling	4.09
	Completeness of facilities	4.06		Security staff behavior	4.09
	Congestion	**3.47**	Assurance	Security and privacy measures	4
	Cleanliness	4		Flight grid	4.13
Empathy	Check-in service staff behavior	4.13		Flight punctuality	**3.75**
	Boarding service staff behavior	4.17		Ambience	**3.93**

After the calculations, it was determined that the highest average satisfaction is observed in the service dimension of boarding service staff behavior, scoring 4.17. In contrast, the lowest average satisfaction is recorded in the price of goods, reaching 3.22. Fourteen are identified, including price of goods, parking price, airlines regulations, form of boarding, accessibility, congestion, passport control time, security check time, check-in time, boarding time, baggage claim time, staff behavior in responding to specific situations, flight punctuality, and ambience. Notably, all services in the reliability dimension have average satisfaction scores below 4, signaling a need for specific attention to enhance this dimension.

3.5. Binary Loigstic Regression

3.5.1. Assumptions

1. No Perfect Multicollinearity

The assumption of no perfect multicollinearity is a crucial prerequisite that must be satisfied before conducting Binary Logistic Regression analysis to ensure reliable results [23]. The results can be observed in Table 7. If the VIF value for each independent variable is less than 5 and the tolerance value is greater than 0.2, it is considered an indication that there is no significant issue related to multicollinearity [24].

Table 7. No perfect multicollinearity

Coefficients								
Model		Unstandardized B	Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	Collinearity Tolerance	Statistics VIF
1	(Constant)	-.485	.225		-2.158	.034		
	X1	-0.18	.050	-.044	-.361	.719	.530	1.886
	X2	.078	.054	.195	1.448	.151	.423	2.366
	X3	.079	.074	.160	1.073	.286	.345	2.899
	X4	-.033	.073	-.074	-.456	.649	.294	3.397

Model		Unstandardized B	Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	Collinearity Tolerance	Statistics VIF
	X5	.054	.065	.116	.834	.407	.395	2.529
	X6	-.083	.057	-.197	-1.455	.149	.419	2.387
	X7	.002	.070	.003	.023	.982	.360	2.781
	X8	.105	.076	.197	1.369	.174	.371	2.697
	X9	.107	.068	.230	1.581	.118	.364	2.744
	X10	-.103	.075	-.212	-1.367	.175	.318	3.145
	X11	-.068	.054	-.169	-1.270	.208	.434	2.303
	X12	.063	.058	.138	1.082	.282	.473	2.116
	X13	-.059	.061	.140	-.969	.335	.369	2.709
	X14	.171	.07	.363	2.453	.016	.350	2.855

All independent variables (X) have VIF values below 5 and tolerance values above 0.2. This indicates that the regression model meets the requirements of the assumption of no perfect multicollinearity. This provides a strong basis to proceed with Binary Logistic Regression analysis with confidence that high correlation among independent variables is not an issue.

2. Linearity

The Wald Test is employed to test the hypothesis of the linearity assumption in the context of logistic regression [23]. H0 posits a linear relationship between the independent variables and the dependent variable in logistic regression, while H1 acknowledges a lack of a linear relationship between the independent variables and the dependent variable in logistic regression [29]. The results of the Wald test in Table 8 show the linearity of the relationship between the independent and dependent variables.

Table 8. Linearity

	Wald Test		
Source	**DF**	**Chi-Square**	**P-Value**
Regression	41	12.55	1.000
X1	4	4.33	0.363
X2	4	5.21	0.267
X3	4	1.88	0.758
X4	4	1.44	0.837
X6	4	3.89	0.422
X7	4	2.57	0.633
X8	3	5.17	0.16
X10	3	2.73	0.436
X11	4	4.3	0.367
X13	4	0.63	0.96
X14	3	3.24	0.357

As seen in Table 8, the p-value for all independent variables (X) exceeds 0.05. This indicates that the overall independent variables (X) do not have a statistically significant impact on the dependent variable in the logistic regression model being tested, or the null hypothesis (H0) is accepted. Therefore, it can be concluded that the linearity assumption is satisfied, providing a strong foundation to proceed with Binary Logistic Regression analysis.

3.5.2. Independent Variables

Fourteen independent variables (X) representing services that fall below customer satisfaction standards have been identified. These variables include: price of goods sold (X1), parking price (X2), airline regulations (X3), form of boarding (X4), accessibility (X5), congestion (X6), passport control time (X7), security check time (X8), check-in time (X9), boarding time (X10), baggage claim time (X11), staff behavior in responding to specific situations (X12), flight punctuality (X13), and ambience (X14). These designations contribute to the formulation of the binary logistic regression mathematical model.

3.5.3. Binary Dependent Variable

In binary logistic regression analysis, the dependent variable (Y) is binary, having only two possible outcomes [9]. The outcome being predicted in this research is whether customers feel satisfied or unsatisfied with the overall quality of services provided by Soekarno-Hatta International Airport. The occurrence (Y) related to customer satisfaction is symbolized by the value 1, while the non-occurrence related to customer satisfaction is symbolized by the value 0. The results of substituting these values are presented in Table 9.

Table 9. Binary dependent variable

Y	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14
1	3	3	3	3	3	3	3	4	5	3	3	3	3	3
1	3	4	3	2	2	2	4	2	4	4	4	2	2	4
1	4	3	3	4	3	4	4	5	4	4	3	5	4	4
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
1	4	5	5	5	5	4	5	4	5	5	4	5	5	4
1	5	5	5	5	5	4	5	5	5	5	4	5	5	5
1	3	3	4	3	4	2	4	3	3	3	2	3	4	4

3.5.4. Binary Logistic Regression Summary

In constructing the binary logistic regression model, it is crucial to ensure that all independent variables (X) significantly influence the dependent variable (Y). Although there were initially 14 independent variables, the analysis indicates that not all of them have a significant impact. Therefore, the approach taken involves eliminating one independent variable (X) with the largest probability or Pr (> |z|), or in other words, the least significant one. Following that, the model is retested to verify that all independent variables significantly influence the dependent variable. If the result shows that not all independent variables (X) are significant, the elimination process is repeated until all independent variables (X) are significant. In this research, this process is repeated for 13 iterations, and the results show that only two independent variables have a significant impact on satisfaction events, namely variable X2 (parking price) and X14 (ambience). The summary results of Binary Logistic Regression are attached in Figure 1 Parking prices and ambiance significantly influence passengers' moods as they are the first aspects encountered before engaging with other services. Reasonable parking fees and a pleasant ambiance can positively shape passengers' initial experiences, enhancing overall satisfaction.

```
Call:
glm(formula = Y ~ X2 + X14, family = "binomial", data = df)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-2.4599  -0.8135   0.4488   0.7584   1.5918

Coefficients:
            Estimate Std. Error z value Pr(>|z|)
(Intercept)  -3.5439     1.1084  -3.197  0.00139 **
X2            0.5728     0.2829   2.025  0.04291 *
X14           0.7311     0.3087   2.368  0.01788 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 117.930  on 98  degrees of freedom
Residual deviance:  96.134  on 96  degrees of freedom
  (1 observation deleted due to missingness)
AIC: 102.13

Number of Fisher Scoring iterations: 5
```

Figure 1. Binary logistic regression summary

From the summary of binary logistic regression shown in Figure 1. Binary logistic regression summarywe can derive equations for the probability of satisfied customers, as observed in Eq. (4), and the probability of dissatisfied customers, as observed in Eq. (5). Furthermore, we can also derivethe Akaike Information Criterion (AIC) is obtained with a value of 102.13. The AIC is utilized to assess the best model based on research data, where the lowest AIC value indicates the superior model [30]. Further investigation of alternative models in the context of the analysis is necessary to confirm the superiority of this research model.

$$P_{y=1} = \frac{e^{-3.5439+0.5728X_2+0.7311X_{14}}}{1 + e^{-3.5439+0.5728X_2+0.7311X_{14}}} \tag{4}$$

where,
$P_{y=1}$ = probability of passenger satisfaction
$\propto$ = estimate std. intercept (summary)
X_i = independent variabel i
β_i = estimate std. X_i (summary)

$$P_{y=0} = \frac{1}{1 + e^{-3.5439+0.5728X_2+0.7311X_{14}}} \tag{5}$$

where,
$P_{y=0}$ = probability of passenger dissatisfaction
$\propto$ = estimate std. intercept (summary)
X_i = independent variabel i
β_i = estimate std. X_i (summary)

3.5.5. Prediction Model

Prediction model has been constructed using only significant variables, namely variables X2 (parking price) and X14 (ambience) on the x-axis, and the dependent variable Y (satisfaction) on the y-axis. The model is presented in Figure 2

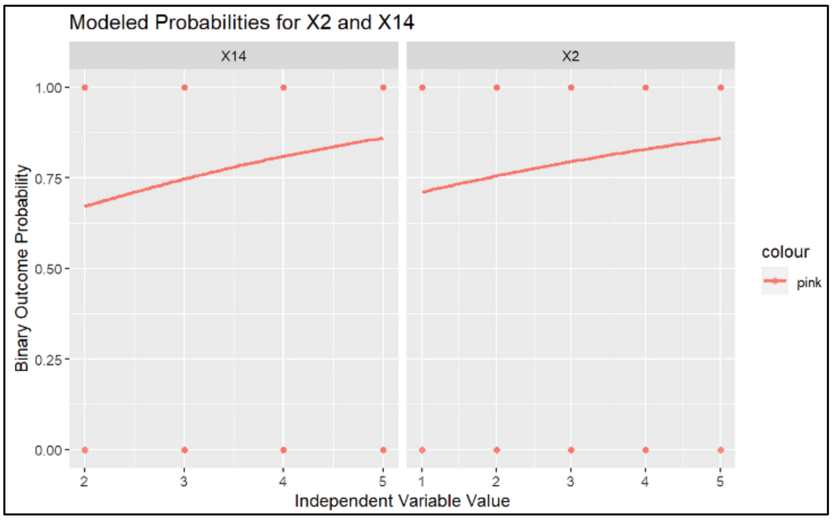

Figure 2. Prediction model

The questionnaire used in this study adopts a Likert Scale of 1-5, causing data points to be distributed within that range and resulting in clustering around those numbers. Additionally, it should be noted that the prediction curve cannot form an S-curve because the obtained data is discrete and not continuous. The primary purpose of this prediction curve is to model the relationship between independent variables and the probability of an occurrence of a binary event, namely the satisfaction level of customers toward Soekarno-Hatta International Airport.

3.5.6. Prediction

By utilizing the significant variables X2 (parking price) and X14 (ambience), simulations of values are performed to predict the outcome probability of the satisfaction level of respondents. The threshold value of 0.5 is used to differentiate between satisfied and dissatisfied categories. If the predicted value was greater than 0.5, the binary outcome was assigned as 1, indicating satisfaction. Conversely, if the predicted value was less than 0.5, the binary outcome was assigned as 0, indicating dissatisfaction. The predicted results are presented in Table 10.

Table 10. Prediction results

	X2	X14	Y	Predicted
35	3	3	1	0.1811026
90	4	4	1	0.1811026
33	3	4	1	0.2816959
.	.	.	.	.
91	5	4	1	0.9514658
95	5	5	1	0.9514658
99	3	4	1	0.9514658

Table 10 reveals a discrepancy between Binary Outcome predictions and actual values (Y), indicating potential inaccuracies in the model. The misalignment between the predictive model and the actual outcome suggests the necessity for additional refinement and validation of the model. Furthermore, unaccounted external factors such as economic conditions and cultural expectations can vary significantly among passengers, introducing potential inaccuracies in predicting outcomes. Increasing the sample size with different time intervals can enhance the model's robustness and generalizability by capturing a broader range of patterns over time. However, it's crucial to ensure that the chosen intervals are meaningful and aligned to maintain coherence in the analysis.

3.5.7. Odds Ratio

Using Logistic Regression, odds ratio values can be obtained [31]. Odds ratio is employed to measure the relative influence of independent variables on the dependent variable in binary logistic regression analysis [26]. The calculated odds ratio values for the independent variables X2 (parking price) and X14 (ambience) are presented in Table 11.

Table 11. Odds ratio

	Predictor	OddsRatio	LowerCI	UpperCI
(Intercept)	(Intercept)	0.0288995	0.1172406	903.699
X2	X2	17.732.783	33.828.652	1.025.570
X14	X14	20.773.711	43.590.382	1.462.147

Based on the odds ratio calculations in Table 11, the odds ratio value for X2 (parking price) is 1.7732783, and for X14 (ambience), it is 2.0773711. This implies that the variable X2 (parking price) has a chance 1.7732783 times higher to increase the likelihood of customer satisfaction, while the variable X14 (ambience) has a chance 2.0773711 times higher to enhance the likelihood of customer satisfaction.

3.5.8. Model Evaluation

1. F1-Score

F1-score is utilized due to the imbalanced distribution of satisfaction levels (Y) between positive (satisfied) and negative (unsatisfied) classes [32]. In this study, there are 71 satisfied respondents and 29 dissatisfied respondents out of a total of 100 respondents. The F1-score ranges from 0 to 1 [28], where higher values indicate better model performance [27]. The calculated F1-Score is shown in Figure 3.

```
[1] "F1-Score: 0.773333333333333"
```

Figure 3. F1-Score

A value of 0.77 is obtained for F1-Score. This value indicates that the Binary Logistic Regression model has a good balance between precision and recall, and is effective in accurately classifying both classes.

2. Area under the Receiving Operating Characteristic Curve (AUC-ROC)

AUC-ROC is employed to measure the accuracy level of the Binary Logistic Regression model. An AUC-ROC value exceeding 0.5 indicates that the model has the ability to distinguish between classes better than a random performance model [33]. The calculated F1-Score is shown in Figure 4.

```
[1] "AUC-ROC: 0.533450704225352"
```

Figure 4. AUC-ROC

The AUC-ROC value obtained is 0.533. In this case, the model demonstrates the ability to distinguish between classes, although not as optimally as desired. This could be a consideration for improvement in future research.

3.5.9. Questionnaire 2 Data Analysis

With responses from 100 participants through Questionnaire 2, which represents the minimum sample collected determined through the sampling process, we confirm and analyze further regarding two variables that significantly influence the service quality of Soekarno-Hatta International Airport. These variables are X2 (parking price) and X14 (ambience). The summarized data results are presented in Table 12.

Table 12. Questionnaire 2: Data analysis

Question	Category	Frequency	Percentage
Average cost for each use of parking facilities	< IDR 25.000	56	56%
	IDR. 25.000 - IDR. 50.000	35	35%
	IDR. 50.000 - IDR. 75.000	4	4%
	> IDR 75.000	5	5%
Reasons for using private transportation	Comfort	27	27%
	Convenience	27	27%
	Speed	23	23%
	Flexibility	11	11%
	Practicality	4	4%
	Safety	3	3%
	Cost Saving	3	3%
	Preference for other vehicles (taxi)	2	2%
Does toll fees contribute significantly to the overall cost of journey?	Yes	77	77%
	No	22	22%
	Not using toll	1	1%
Waiting time incurred to park and leave the parking area	< 1 minute	1	1%
	1 minute - 3 minute	27	27%
	3 minute - 5 minutes	32	32%
	> 5 minutes	35	35%
Main Parking Issues	Limitation of parking slots	31	31%
	Accessibility	16	16%
	Flow Neatness	15	15%
	None	13	13%
	Price	8	8%
	Security	8	8%
	Direction sign clarity	7	7%
	Facilities (roof, exit counters)	2	2%

Question	Category	Frequency	Percentage
Level of noise at Soekarna-Hatta International Airport	Not disturbing	73	73%
	Very disturbing	16	16%
	Disturbing	11	11%
Does the lighting and colors at Soekarno-Hatta International Airport create a pleasant ambience?	Yes	63	63%
	No	24	24%
	Average	13	13%

Table 12 shows that over half of the respondents (56%) spend less than Rp 25,000.00 for parking at Soekarno-Hatta International Airport, suggesting they may not strongly object to the parking price. 3% of respondents prefer private vehicle use due to cost-effectiveness, while 77% consider toll fees a significant contributor to travel expenses. This perception affects overall travel costs to Soekarno-Hatta International Airport and shapes their perspective on the high parking prices at the airport. Moreover, 35% of respondents wait for over 5 minutes, and a substantial 87% express complaints about parking facilities at Soekarno-Hatta International Airport. This may indicate that respondents may feel that the fees charged do not align with the quality of service provided. Additionally, 27% of respondents stated that they felt disturbed, indicating that some respondents experience discomfort during their journey due to the atmosphere at Soekarno-Hatta International Airport. Furthermore, about 37% of respondents have not fully experienced a pleasant atmosphere, signaling the potential for improvement in creating a more enjoyable ambience at Soekarno-Hatta International Airport to enhance customer satisfaction.

4. CONCLUSION AND SUGGESTIONS

The study on enhancing customer satisfaction at Soekarno-Hatta International Airport using the SERVQUAL method and Binary Logistic Regression has yielded several important conclusions. Firstly, the SERVQUAL method identified 14 services at the airport that fail to meet customer satisfaction standards. These services include the price of goods, parking price, airline regulations, the form of boarding, accessibility, congestion, passport control time, security check time, check-in time, boarding time, baggage claim time, staff behavior in responding to specific situations, flight punctuality, and the overall ambiance.

Furthermore, the SERVQUAL method revealed that services within the reliability dimension have average satisfaction scores below 4. This finding indicates a need for special attention to enhance the reliability dimension to meet customer expectations better. On the other hand, Binary Logistic Regression analysis showed that among the 14 services identified, only the variables related to parking price and ambiance significantly influence customer satisfaction.

The designed Binary Logistic Regression model has an F1-Score of 0.773333 and an AUC-ROC value of 0.533451. These metrics suggest that the model performs reasonably well in terms of precision and recall but possesses moderate ability in differentiating between classes, indicating room for improvement. Additionally, the regression analysis found that improvements in parking price and ambiance could increase customer satisfaction by 1.7732783 times and 2.0773711 times, respectively.

The study emphasizes the need to focus on improving operational accuracy through stringent Standard Operating Procedures (SOPs) and comprehensive staff training. Prioritizing the quality and pricing of parking services is essential, along with creating a favorable ambiance. This includes reducing supplementary expenses like toll charges, expanding parking facilities, optimizing parking flow, improving lighting, improving customer engagement, and implementing noise control measures.

The authors suggest that future research should compare AIC values between logistic regression models from this study and others to assess model efficacy and robustness. This comparison aims to further enhance customer satisfaction at Soekarno-Hatta International Airport by identifying and implementing the most effective strategies.

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