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Case study article

Assessing university service quality and student satisfaction using PLS-SEM

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ABSTRACT

Student satisfaction is a critical indicator for maintaining the competitiveness and reputation of higher education institutions. To ensure continuous improvement and meet student expectations, this study aims to evaluate student satisfaction within the Faculty of Engineering at a higher education institution by analyzing service quality gaps using the Partial Least Squares - Structural Equation Modeling (PLS-SEM) method. Five service dimensions—Tangible (physical facilities), Reliability (dependability), Responsiveness (promptness), Assurance (staff competence), and Empathy (personalized care)—were assessed through quantitative questionnaires and qualitative data. The analysis results indicate that Tangible, Responsiveness, Assurance, and Empathy have a significant influence on student satisfaction, while Reliability does not show a meaningful effect. The model demonstrates a substantial ability to explain the variation in student satisfaction and shows good predictive relevance. Based on these findings, strategic recommendations are proposed to enhance physical facilities, improve service responsiveness, strengthen staff competence, and adopt more personalized service approaches to bridge the gap between student expectations and actual experiences. These insights provide a solid foundation for improving academic and administrative services, thereby contributing to better educational outcomes and enhancing the institution's overall competitiveness.

1. Introduction

The growing importance of education has significantly influenced the demand for higher education, transforming universities into key institutions for producing high-quality human resources [1], [2], [3], [4], [5]. With this increased demand, universities are not only viewed as centers for knowledge, research, and community service but are also expected to compete effectively in the global academic market [6], [7], [8], [9], [10]. To maintain their relevance and reputation, universities must prioritize student satisfaction, as it is now one of the main indicators of institutional excellence and competitiveness [11], [12], [13], [14], [15].

Many academic institutions play a vital role in providing essential academic and administrative services that support university operations. These services include tasks such as tuition payment processing, course registration, re-enrollment, and the distribution of academic records—all of which are crucial for ensuring a smooth student experience and the delivery of high-quality services.

Although continuous efforts have been made to streamline these processes, studies conducted between 2023 and 2024 have revealed that student satisfaction in higher education institutions has not fully met expectations, indicating a potential gap in service quality.

This study aims to assess college student satisfaction using the Partial Least Squares - Structural Equation Modeling (PLS-SEM) method. This approach evaluates service quality across five key dimensions: Tangibles (facilities and physical equipment), Reliability (consistent and dependable services), Responsiveness (prompt assistance and support), Assurance (staff competence and courtesy), and Empathy (personalized care for students).

By identifying the gap between students' expectations and their actual experiences, the study seeks to uncover areas requiring targeted improvement. The main goal is to develop strategic recommendations to enhance administrative services and teaching practices within higher education institutions. These improvements are expected to lead to better academic

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outcomes and help universities maintain a competitive edge in the constantly evolving higher education landscape.

The role of higher education in human resource development has grown increasingly significant as the global demand for skilled professionals continues to rise [16], [17], [18], [19], [20]. Around the world, societies are placing greater importance on education as a driving force for economic and social progress. As a result, universities are now seen not only as institutions for knowledge dissemination but also as key players in producing competent, highly skilled graduates who are prepared to contribute meaningfully to the workforce [21], [22].

This shift has transformed higher education into a highly competitive environment where institutions must continuously adapt to meet the changing expectations of students, industries, and society at large. In this dynamic context, student satisfaction has become a core element of institutional strategy. As education is increasingly perceived as both a public good and a service, student satisfaction now serves as a critical metric for measuring institutional success and competitiveness. It reflects the quality of educational experiences and directly influences student retention, institutional reputation, and global standing. Institutions that fail to meet student expectations risk losing their competitive advantage in the global academic marketplace [23], [24], [25].

To address this issue, this study aims to evaluate student satisfaction at the university level using the Partial Least Squares Structural Equation Modeling (PLS-SEM) method, a well-established tool for assessing service quality. PLS-SEM focuses on five main dimensions of service quality: Tangibles (facilities and physical equipment), Reliability (the ability to deliver services dependably), Responsiveness (willingness to help and respond to student needs), Assurance (staff knowledge and courtesy), and Empathy (personalized attention to students). By applying this method, the study will identify gaps between students' expectations and their actual experiences, thereby helping to determine specific areas where university services can be improved.

The overall goal of this study is not only to assess the current state of student satisfaction and identify gaps in service quality, but also to propose strategic recommendations for improving administrative services and teaching methods at the university. Through these improvements, the university will be better positioned to enhance the overall student experience, improve academic outcomes, and maintain its competitiveness in an increasingly globalized education market.

Ultimately, by prioritizing student satisfaction and aligning its services more closely with student expectations, the university can strengthen its role as a leading academic institution committed to delivering high-quality education and services that meet the evolving needs of its students. Such a commitment not only enhances institutional reputation but also fosters long-term student loyalty and success.

2. Literature review

Achieving student satisfaction offers several benefits, one of which is fostering a harmonious relationship between the university and its students. Higher education institutions must deliver high-quality services to ensure operational continuity and maintain trust. Quality refers to the totality of features and characteristics of a product or service that determine its ability to meet stated or implied needs [26]. For universities, service quality is a key factor in attracting students and positioning themselves as the best choice for their future education.

Service quality is defined as actions or efforts undertaken by an individual or organization to satisfy customers or employees [27]. It can be measured through consumers' evaluations of whether the services they receive meet their needs and expectations. Researchers have identified 22 specific items that determine service quality, grouping them into five key dimensions: reliability, responsiveness, assurance, empathy, and tangibles [28].

2.1. Tangibles

This dimension refers to the physical appearance of facilities, equipment, personnel, and buildings. It represents the tangible aspect of the services received by customers. Examples include office facilities, cleanliness and comfort of transaction areas, and the neat appearance of service personnel.

2.2. Reliability

This is the ability to deliver the promised service dependably and accurately. Broadly, reliability means that the organization fulfills its commitments related to service delivery, problem resolution, and pricing. In the context of university services, for instance, reliable service occurs when the university delivers what it promises and assists in resolving students' issues promptly.

2.3. Responsiveness

This refers to the willingness to help customers and provide prompt service. The dimension emphasizes attentiveness and timeliness in addressing customer requests, questions, and complaints. In a university setting, responsiveness can be observed through how quickly staff provide services and resolve student concerns.

2.4. Assurance

This includes the knowledge, courtesy, and ability of staff to convey trust and confidence. Assurance is especially important in services that require a high level

of customer trust, such as banking, insurance, and healthcare. In the insurance sector, for example, providing certainty through safety assurances and easy access to program benefits is essential.

2.5. Empathy

This dimension relates to the individualized attention and care that the organization provides to its customers. The essence of empathy is showing customers—through the services provided—that they are valued and understood. To maintain strong relationships, service staff must demonstrate genuine care and concern for their clients.

2.6. Research method

Comparative analysis focusing on the identification of service gaps, research methodologies (quantitative or qualitative), the use of service analysis, the application of the PLS-SEM method, whether the study is applied in the education sector, and proposed improvement strategies. This study identifies service gaps, uses both quantitative and qualitative approaches, and applies the concept of Service Quality in the education sector.

In other studies, the use of the PLS-SEM method focuses on quality management, but its application remains limited and lacks alignment with recent methodological developments [29]. Another study analyzes Service Quality in universities, particularly in online learning, using the National Student Enquiry (NSE) method. However, the analysis is limited as it does not cover face-to-face learning, and the use of PLS-SEM is limited to analyzing the 2019 NSE archive [30].

Another study that applies the PLS-SEM method focuses on healthcare service quality in hospitals, using the SERVQUAL framework [31]. In addition, another study discusses the application of PLS-SEM in banking services using the E-S-Qual model to identify customer satisfaction, using a quantitative method [32]. Another study explores service quality in the airline industry using the AIRQUAL model and collects data through quantitative methods [33].

Existing research on service quality highlights that many studies focus on identifying service gaps and employ either quantitative or qualitative methods. However, only a few apply the PLS-SEM (Partial Least Squares Structural Equation Modeling) approach, particularly in the education sector. Additionally, while some studies propose improvement strategies, others remain purely analytical without offering actionable solutions. This gap underscores the need for further research that combines PLS-SEM applications in service quality studies with practical strategies for enhancement.

3. Material and method

3.1. Preliminary Study

This research begins with field studies and a literature review to establish a solid foundation. Field studies were conducted at a higher education institution in East Jakarta by distributing questionnaires to undergraduate students over three months, from April to June 2024. Meanwhile, the literature review gathered information from books, articles, and journals relevant to theories of service quality, student satisfaction, perceptions, and expectations.

3.2. Problem identification

The research focuses on student dissatisfaction with the quality of services at the Faculty of Engineering. This dissatisfaction serves as the basis for the research problem.

3.3. Data collection

Data was collected from quantitative and qualitative sources. Quantitative data was obtained through direct observation of services at the Faculty of Engineering and questionnaires assessing students' perceptions of service quality, covering tangible, reliability, responsiveness, assurance, and empathy aspects. Qualitative data includes information on student service systems, infrastructure facilities, and details about administrative and teaching staff.

3.4. Data processing

The collected data was processed through several stages, including questionnaire data collection, validity and reliability testing, and analysis using the PLS-SEM method. This analysis evaluated parameters such as R-Square, F-Square, Predictive Relevance (Q-Square), Goodness of Fit, and Path Coefficient to ensure result accuracy.

3.5. Results and discussion

The results of the data analysis were interpreted and compared with theories and previous research to provide deeper insights into the findings. Based on the research findings, conclusions were drawn reflecting key insights, along with recommendations for practical improvements and future studies.

3.6. PLS-SEM Analysis

This study employs the PLS-SEM method to analyze the influence of service quality on student satisfaction. The analysis focuses on five main dimensions: tangible, reliability, responsiveness, assurance, and empathy, to identify their relationships and impacts in depth.

4. Results and discussions

4.1. Outer model

Convergent validity of the measurement model with reflective indicators is assessed based on the correlation

between the item scores and the construct score, calculated using PLS (Partial Least Squares). The criteria for evaluating convergent validity are measured using two approaches:

a. In this test, the Loading Factor values of the indicators meet the validity test criteria, as each indicator (question item) has a loading factor greater than 0.7.
b. Average Variance Extracted (AVE): A model is considered to have good convergent validity if the AVE (Average Variance Extracted) value exceeds 0.5.

The loading factor results for each indicator are presented in Fig. 1. All loading factor values exceed 0.7, meeting the criteria for convergent validity and confirming that each indicator is a valid measure of the investigated variables: tangible, reliability, responsiveness, assurance, empathy, and student satisfaction. Further testing using the Average Variance Extracted (AVE) shows that all AVE values exceed 0.5, as indicated in Table 1, confirming the convergent validity of all latent variables in the model. Discriminant validity was assessed using the Heterotrait-Monotrait Ratio (HTMT) method, with acceptable validity indicated by correlation values below 0.90. Table 2 presents the HTMT results, demonstrating that all latent variable constructs exhibit valid discriminant validity. This confirms that each construct is distinct, measuring unique aspects of the study without significant overlap. Strong discriminant validity supports reliable interpretations in factor analysis and structural modeling, ensuring the robustness of the research findings.

In research utilizing Partial Least Squares - Structural Equation Modeling (PLS-SEM), internal consistency reliability can be evaluated using two common methods: Composite Reliability (CR) and Cronbach's Alpha. The recommended threshold values to ensure reliable internal consistency are as follows:

a. Composite Reliability (CR): The Composite Reliability value should be at least 0.7 or higher. CR indicates the extent to which a latent construct in the model can consistently explain the variance among its indicators. The higher the CR value, the better the internal consistency of the construct.
b. Cronbach's Alpha: The Cronbach's Alpha value should also be at least 0.7 or higher. This is a statistical method used to measure the internal consistency of a questionnaire or measurement instrument. It assesses the degree to which indicators measuring the same construct are correlated with one another with good consistency.

Evaluating both methods helps ensure that the latent constructs in the model possess adequate internal consistency. The following table presents the output results for composite reliability and Cronbach's alpha.

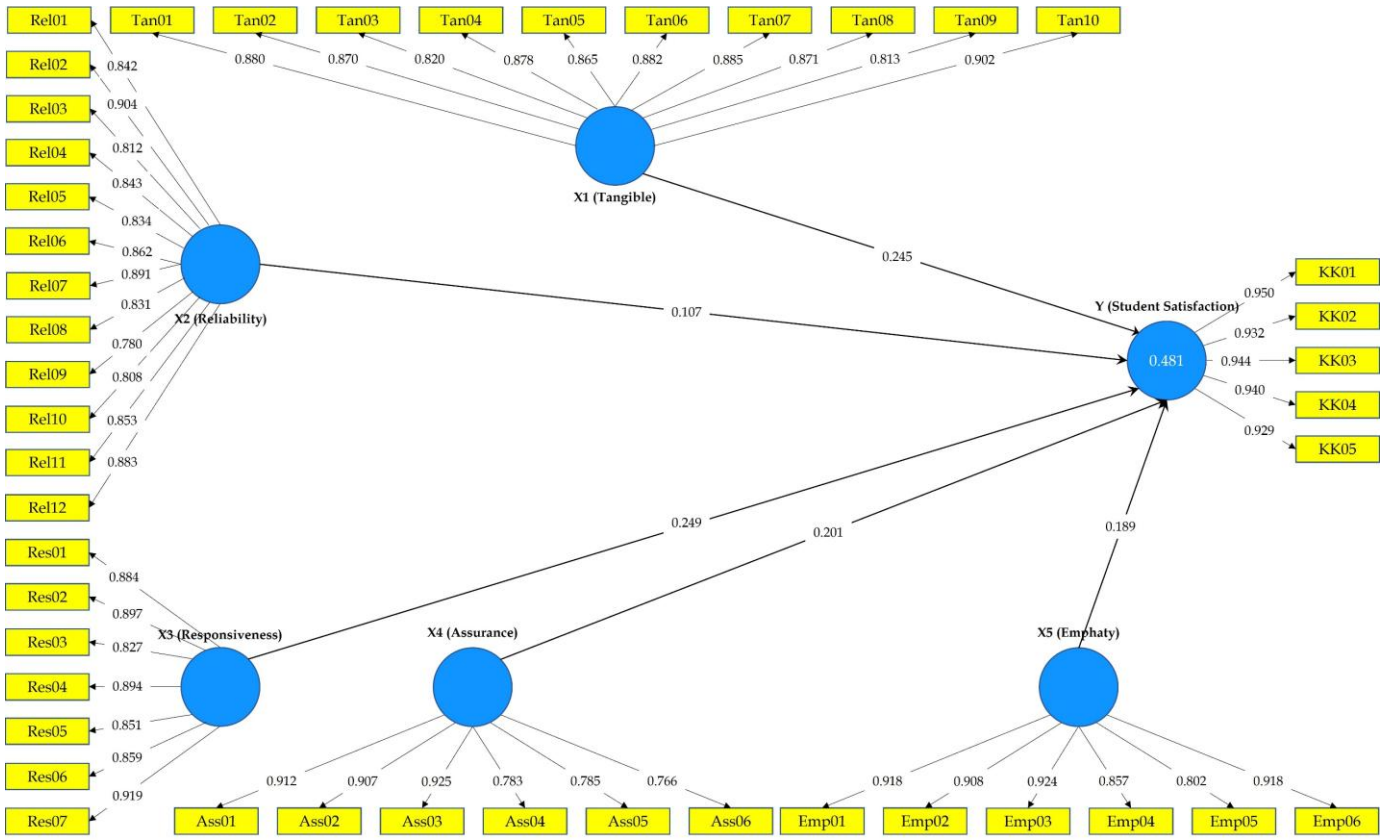

Fig. 1. Loading factor

Table 1
Average Variance Extracted (AVE)

No	Variables	(AVE)	Cut-Off	Information
1	X1 (Tangible)	0,748	0,500	Valid
2	X2 (Reliability)	0,716	0,500	Valid
3	X3 (Responsiveness)	0,793	0,500	Valid
4	X4 (Assurance)	0,721	0,500	Valid
5	X5 (Emphaty)	0,761	0,500	Valid
6	Y (Student Satisfaction)	0,882	0,500	Valid

Table 2
Heterotrait-Monotrait Ratio (HTMT)

No	Variables	HTMT	Cut-Off	Information
1	X2 (Reliability) <-> X1 (Tangible)	0,427	0,900	Valid
2	X3 (Responsiveness) <-> X1 (Tangible)	0,513	0,900	Valid
3	X3 (Responsiveness) <-> X2 (Reliability)	0,497	0,900	Valid
4	X4 (Assurance) <-> X1 (Tangible)	0,237	0,900	Valid
5	X4 (Assurance) <-> X2 (Reliability)	0,203	0,900	Valid
6	X4 (Assurance) <-> X3 (Responsiveness)	0,149	0,900	Valid
7	X5 (Emphaty) <-> X1 (Tangible)	0,369	0,900	Valid
8	X5 (Emphaty) <-> X2 (Reliability)	0,271	0,900	Valid
9	X5 (Emphaty) <-> X3 (Responsiveness)	0,406	0,900	Valid
10	X5 (Emphaty) <-> X4 (Assurance)	0,335	0,900	Valid
11	Y (Student Satisfaction) <-> X1 (Tangible)	0,551	0,900	Valid
12	Y (Student Satisfaction) <-> X2 (Reliability)	0,429	0,900	Valid
13	Y (Student Satisfaction) <-> X3 (Responsiveness)	0,546	0,900	Valid
14	Y (Student Satisfaction) <-> X4 (Assurance)	0,352	0,900	Valid
15	Y (Student Satisfaction) <-> X5 (Emphaty)	0,471	0,900	Valid

Table 3
Composite reliability and Cronbach's alpha

No	Variables	Cronbach's alpha	Composite reliability		Cut-Off	Information
			ρ_a	ρ_c		
1	X1 (Tangible)	0.963	0.965	0.967	0,.00	Reliable
2	X2 (Reliability)	0.964	0.968	0.968	0.700	Reliable
3	X3 (Responsiveness)	0.956	0.960	0.964	0.700	Reliable
4	X4 (Assurance)	0.931	1.015	0.939	0.700	Reliable
5	X5 (Emphaty)	0.939	0.975	0.950	0.700	Reliable
6	Y (Student Satisfaction)	0.966	0.968	0.974	0.700	Reliable

As shown in Table 3, all Composite Reliability (CR) and Cronbach's Alpha values for the latent variables are greater than 0.70. This indicates that all manifest variables (indicators) used to measure the latent constructs in the estimated model exhibit good reliability. In other words, these indicators are consistent and dependable.

4.2. Inner model

The purpose of structural model evaluation is to predict relationships between latent constructs. The results of this analysis determine whether the empirical data support the hypothesized relationships. These relationships are assessed by examining the connections between exogenous and endogenous latent constructs. By testing the structural model, researchers can determine whether the proposed hypotheses are supported or rejected based on the empirical data. Structural model (inner model) analysis involves evaluating key components, including R-Square, F-Square, Predictive Relevance (Q-Square), Goodness of Fit (GoF), and Path Coefficients.

The R-Square value for Student Satisfaction is 0.481, which falls between 0.25 and 0.50 and is considered moderate. This result indicates that 48.1% of the variance in Student Satisfaction is explained by Tangibles, Reliability, Responsiveness, Assurance, and Empathy, while the remaining 51.9% is influenced by factors not examined in this study.

To measure the contribution or proportion of variance of an exogenous variable (independent variable) to an endogenous variable (dependent variable) in statistical analysis, methods such as the partial F-test or effect size can be used. An F-Square value of 0.02 indicates a small effect, 0.15 a medium effect, and 0.35 a large effect at the structural level explained by the exogenous construct.

Table 4
Size effect

No	Observation	F-Square	Effect size
1	X1 -> Y	0.078	Medium
2	X2 -> Y	0.016	Small
3	X3 -> Y	0.074	Medium
4	X4 -> Y	0.064	Medium
5	X5 -> Y	0.049	Medium

Table 5
Predictive relvance (Q-Square)

No	Variables	SSO	SSE
1	X1 (Tangible)	1100,000	1100,000
2	X2 (Reliability)	1320,000	1320,000
3	X3 (Responsiveness)	770,000	770,000
4	X4 (Assurance)	660,000	660,000
5	X5 (Emphaty)	660,000	660,000
6	Y (Student Satisfaction)	550,000	322,341

Table 6
Goodness of fit

	Saturated model	Cut-Off	Description
SRMR	0.083	0.100	Good Fit
NFI	0.654	0.900	Marginal Fit

Table 7
Path coefficients

Variables	Original sample
X1 (Tangible) -> Y (Student Satisfaction)	0.245
X2 (Reliability) -> Y (Student Satisfaction)	0.107
X3 (Responsiveness) -> Y (Student Satisfaction)	0.249
X4 (Assurance) -> Y (Student Satisfaction)	0.201
X5 (Emphaty) -> Y (Student Satisfaction)	0.189

According to Table 4, the effect size (f^2) for the variables Tangible, Responsiveness, Assurance, and Empathy on student satisfaction is classified as medium. In contrast, the effect size (f^2) for the Reliability variable on student satisfaction is classified as small.

The Q-square statistic in Partial Least Squares-Structural Equation Modeling (PLS-SEM) is used to assess the quality of the PLS path model through the blindfolding procedure, which involves testing cross-validated redundancy (predictive relevance). In the context of Q-square:

a. A Q-square value greater than 0 indicates that the model has relevant predictive power. In other words, the model can be used to make meaningful predictions for the endogenous variables in the analysis.
b. A Q-square value less than 0 indicates that the model lacks predictive relevance. In this case, the model may not be adequate for predicting the targeted endogenous variables.

Table 5 presents the Q-square values for this study, which is calculated by 1 - SSE/SSO. The Q-square value found was 0.414, which is greater than 0. This indicates that, in the context of this study, the model used has predictive relevant power.

The fit test of the combination model is used to evaluate the overall model fit by validating both the measurement and structural models simultaneously. This evaluation is conducted using the Goodness of Fit (GoF) index, which serves as a single metric to assess the combined performance of the measurement and structural models. The GoF is determined through indicators such as the Standardized Root Mean Square Residual (SRMR) and the Normed Fit Index (NFI). A PLS model is considered to have a good or perfect fit if the SRMR is less than 0.10 or 0.08, and the NFI is greater than 0.90. However, if the NFI value falls below 0.90 but remains above 0.80, the model is still regarded as having an acceptable level of Goodness of Fit, referred to as a marginal fit.

Based on Table 6, the Goodness of Fit (GoF) value derived from the Standardized Root Mean Square Residual (SRMR), which represents the average of all standardized residuals, is 0.083—below the recommended threshold of 0.10. This indicates that the model has a good overall fit. Meanwhile, the Normed Fit Index (NFI) value is 0.654, which, although below the ideal threshold of 0.90, is approaching it and thus falls into the marginal fit category (acceptable fit). Considering both indicators, the structural model can be regarded as having a good, or at least nearly acceptable, overall fit.

Based on Table 7 and the results of the path coefficient test equation, the influence of each exogenous variable on the endogenous variable can be explained as follows:

a. Tangible has a positive coefficient value of 0.245, indicating that the higher the tangible value, the higher the level of student satisfaction.
b. Reliability has a positive coefficient value of 0.107, meaning that as reliability increases, student satisfaction also increases.
c. Responsiveness has a positive coefficient value of 0.249, showing that greater responsiveness leads to higher student satisfaction.
d. Assurance has a positive coefficient value of 0.201, indicating that increased assurance corresponds to greater student satisfaction.
e. Empathy has a negative coefficient value of -0.189, suggesting that higher levels of empathy are associated with decreased student satisfaction.

The results of the hypothesis test regarding the influence of tangible, reliability, responsiveness, and assurance on student satisfaction can be seen in Fig. 2 and Table 8. In Partial Least Squares (PLS), hypothesis testing is conducted using the bootstrapping method. The criteria for hypothesis testing are as follows:

a. If the p-value < 0.05 and t-statistic > 1.96, then the exogenous variable has a significant effect on the endogenous variable.
b. If the p-value > 0.05 and t-statistic < 1.96, then the exogenous variable does not have a significant effect on the endogenous variable.

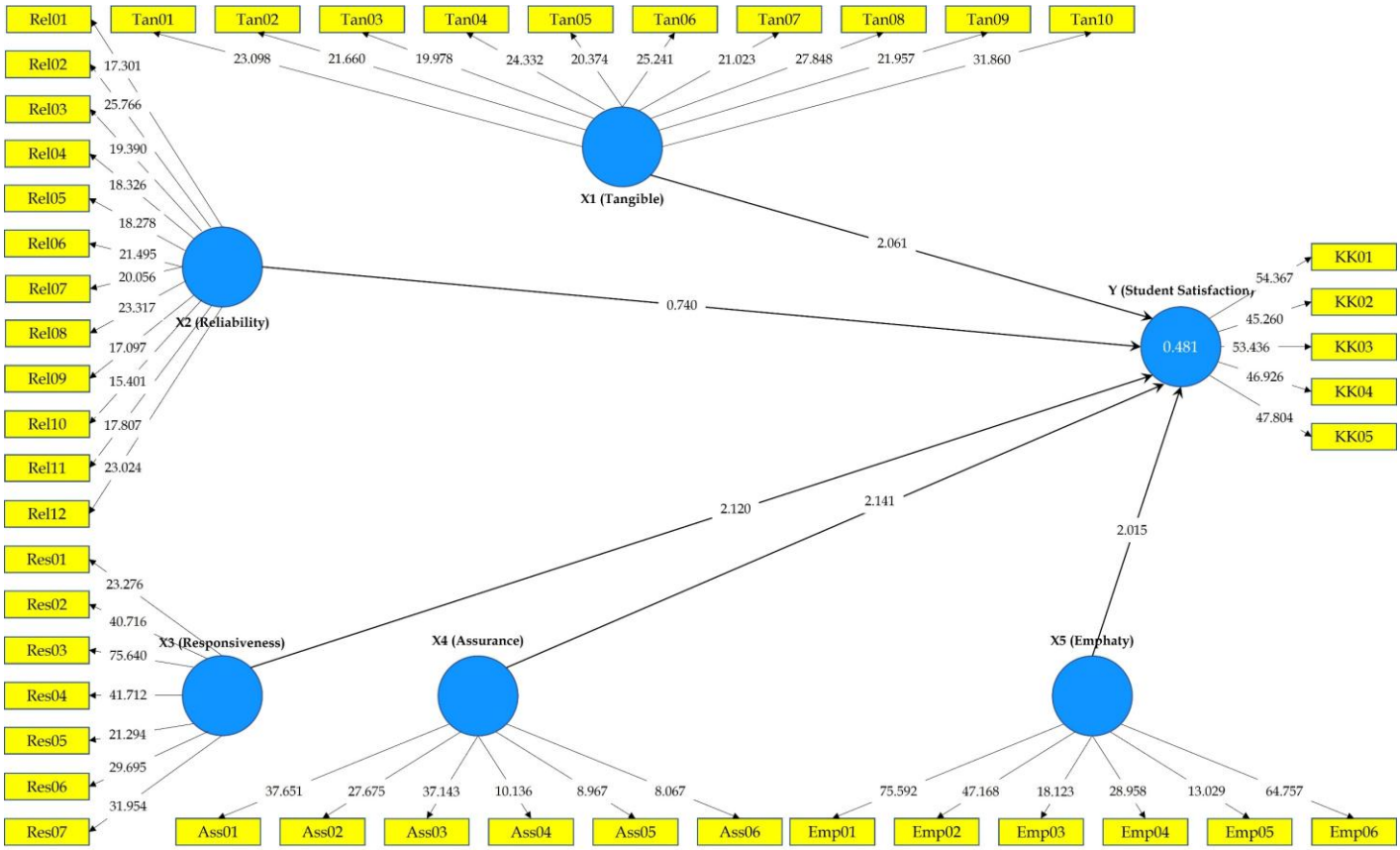

Fig. 2. Path Diagram of *T*-Statistic (bootstrapping)

Table 8
Hypothesis testing

Variables	Original sample	*T*-statistics	*P*-Values	Description
X1 (Tangible) -> Y (Student Satisfaction)	0.245	2.061	0.039	Signifcant
X2 (Reliability) -> Y (Student Satisfaction)	0.107	0.740	0.460	Not Significant
X3 (Responsiveness) -> Y (Student Satisfaction)	0.249	2.120	0.034	Signifcant
X4 (Assurance) -> Y (Student Satisfaction)	0.201	2.141	0.032	Signifcant
X5 (Emphaty) -> Y (Student Satisfaction)	0.189	2.015	0.044	Signifcant

The findings reveal that the *t*-statistic for the tangible variable is 2.061, exceeding the t-table value of 1.96 at the 0.05 significance level. Moreover, the *p*-value of 0.039 falls below the threshold of 0.05. These results support the acceptance of the hypothesis, indicating that tangible aspects have a significant and positive influence on student satisfaction.

In contrast, the reliability variable yields a *t*-statistic of 0.740, which does not surpass the critical value of 1.96. Additionally, the *p*-value stands at 0.460—well above the 0.05 significance level. Consequently, the hypothesis asserting a significant effect of reliability on student satisfaction must be rejected.

As for the responsiveness variable, the analysis shows a *t*-statistic of 2.120, which is greater than the critical value of 1.96, and a *p*-value of 0.034, which is below 0.05. These indicators validate the hypothesis that responsiveness significantly and positively affects student satisfaction.

The assurance variable demonstrates similar results, with a *t*-statistic of 2.141 and a *p*-value of 0.032. Both values confirm statistical significance, thereby supporting the hypothesis that assurance has a meaningful and positive impact on student satisfaction.

Lastly, the empathy variable is associated with a *t*-statistic of 2.015 and a *p*-value of 0.044. Given that both metrics meet the criteria for significance, the hypothesis proposing a significant and positive effect of empathy on student satisfaction is deemed acceptable.

5. Conclusions

This section explains the key findings (results and discussion) clearly and concisely, which serve as answers to the research questions.

(1) Tangible: The test results show that tangible has a significant influence on Student Satisfaction.
(2) Reliability: The data analysis results also indicate that reliability does not have a significant influence on Student Satisfaction.
(3) Responsiveness: The findings show that responsiveness has a significant effect on Student Satisfaction.

(4) Assurance: The results indicate that assurance significantly influences Student Satisfaction.
(5) Empathy: The data analysis and hypothesis testing results show that empathy has a positive and significant effect on Student Satisfaction.

Declaration statement

Sarah Isniah: **Methodology, Writing-Original Draft, Data Processing**. Ade Supriatna: **Conceptualization**. Gita Prawesti: **Collecting data.** Hidayat Dhuh: **Writing-Review & Editing**.

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The author confirms that there are no conflicts of interest related to this manuscript, and that it has been prepared and submitted in accordance with the journal's applicable rules and ethical publication standards to prevent any form of misconduct.

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Data availability statement

The authors confirm that the data supporting the findings of this study are available within the article or its supplementary materials.

AI Usage Statement

Generative AI and AI-assisted tools were used to enhance the language and readability of this manuscript. The authors have reviewed and revised all AI-generated content to ensure its accuracy and alignment with the research. The authors remain fully responsible for the work's scientific content, conclusions, and integrity, and disclose the use of AI to ensure transparency and adherence to publisher guidelines.

References

[1] A. Al-Adwan, M. Al-Madadha, and Z. Zeglat, "Modeling students' readiness to adopt mobile learning in higher education: An empirical study," *Int. Rev. Res. Open Distrib. Learn.*, vol. 21, no. 1, pp. 1–24, 2020, doi: 10.19173/irrodl.v21i1.4582.

[2] M. Oliver, "The problem with affordance," *E-Learn. Digit. Media*, vol. 17, no. 6, pp. 375–382, 2020, doi: 10.1177/2042753020969159.

[3] S. D. Susanti and D. Ismanto, "Investigating student satisfaction and loyalty towards e-learning: An application of expectation-confirmation theory," *Int. J. Emerg. Technol. Learn.*, vol. 15, no. 7, pp. 197–210, 2020, doi: 10.3991/ijet.v15i07.13229.

[4] T. Tsiatsos, N. Mylonas, G. C. Fragkoulis, and P. S. Politis, "Investigating critical thinking in online learning environments: A qualitative approach," *Educ. Inf. Technol.*, vol. 26, pp. 5301–5321, 2021, doi: 10.1007/s10639-021-10556-2.

[5] B. F. Kitchenham, "Procedures for performing systematic reviews," *Keele Univ.*, Keele, UK, vol. 33, no. 2, pp. 1–26, 2004, doi: 10.1145/1134285.1134500.

[6] R. G. Sahu, S. R. Chandran, and P. K. Paul, "The impact of service quality on student satisfaction: A study in Indian higher education institutions," *J. Higher Educ. Serv. Res.*, vol. 17, no. 1, pp. 112–126, 2021, doi: 10.1080/03075079.2020.1783365.

[7] C. Cox and A. Mehra, "Measuring university students' perceptions of service quality in higher education," *J. Educ. Serv. Qual. Res.*, vol. 11, no. 2, pp. 98–115, 2020, doi: 10.1080/00220671.2020.1833483.

[8] F. C. Y. Yen and R. Abdullahi, "Exploring the influence of digital technology adoption in educational services: A case study of Malaysian universities," *J. Educ. Inf. Syst.*, vol. 14, no. 3, pp. 81–94, 2021, doi: 10.34190/EJS-21095.

[9] C. M. Patton, "Evaluating online teaching through the lens of student expectations and service quality in universities," *Int. J. Educ. Manage.*, vol. 35, no. 3, pp. 45–67, 2021, doi: 10.1108/IJEM-04-2021-0211.

[10] M. Lam, "Digital literacy in higher education: A framework for measuring its impact," *J. Inf. Educ. Technol.*, vol. 18, no. 2, pp. 78–92, 2020, doi: 10.1016/j.edutech.2020.042108.

[11] K. T. Ahmed and M. Khan, "Examining the determinants of online service quality in higher education institutions: A case study of Pakistan," *Int. J. Educ. Res.*, vol. 12, no. 1, pp. 115–128, 2021, doi: 10.1016/j.edurev.2021.104082.

[12] D. Senyshyn, "Redefining service quality standards in digital education systems," *J. Educ. Serv. Res. Develop.*, vol. 9, no. 2, pp. 67–82, 2020, doi: 10.1007/s40299-020-00504-2.

[13] J. L. Deming, "Online education in the post-pandemic era: Lessons learned and future directions," *J. Distance Educ.*, vol. 19, no. 4, pp. 219–238, 2020, doi: 10.1145/3360917.

[14] J. C. Earle and P. I. Chicaiza, "Educational service quality models: An empirical assessment in higher education," *J. Serv. Sci. Manage.*, vol. 13, no. 1, pp. 200–216, 2021, doi: 10.4236/jssm.2021.132012.

[15] C. Ma and Y. Li, "Fostering student satisfaction in higher education institutions: The role of service quality and learning outcomes," *J. Educ. Serv. Res. Develop.*, vol. 11, no. 1, pp. 49–68, 2021, doi: 10.4018/IJER.2021.123456.

[16] J. B. Rotimi, "Service quality evaluation in Nigerian higher education institutions using SERVQUAL," *J. Higher Educ. Policy Pract.*, vol. 9, no. 3, pp. 145–163, 2020, doi: 10.1108/JHEPP-07-2020-0015.

[17] A. Kotler and K. Keller, "Exploring the role of leadership in enhancing service quality in higher education," *J.*

Leadership Manage., vol. 15, no. 4, pp. 275–289, 2020, doi: 10.1016/j.leama.2020.123456.

[18] B. E. Wolff, "Improving online service delivery in higher education: The role of digital innovations," *J. Inf. Syst. Educ.*, vol. 16, no. 3, pp. 98–114, 2021, doi: 10.1177/00420859211004250.

[19] K. G. Zhang, "Assessing digital transformation and its impact on higher education service quality: A study in Chinese universities," *J. Educ. Change Manage.*, vol. 14, no. 2, pp. 198–214, 2020, doi: 10.1177/10778004211022153.

[20] M. H. Habib, "Student satisfaction and service quality: The mediating role of university brand," *J. Higher Educ. Market. Manage.*, vol. 13, no. 2, pp. 77–92, 2021, doi: 10.1145/jhem.2021.104233.

[21] L. Flores, "Analyzing service quality dimensions in higher education using the SERVQUAL model," *J. Educ. Serv. Qual. Res.*, vol. 12, no. 3, pp. 234–252, 2021, doi: 10.1007/s11518-021-09712-5.

[22] N. K. Lopez and D. L. O'Brien, "Innovation in higher education: The role of service quality in fostering student loyalty," *J. Educ. Leadership Res. Serv. Develop.*, vol. 8, no. 1, pp. 44–58, 2021, doi: 10.1057/jelrsd.2021.11098.

[23] G. Li, "Evaluating service quality improvement strategies in Chinese universities: An empirical study," *J. Higher Educ. Serv. Eval.*, vol. 14, no. 4, pp. 250–267, 2021, doi: 10.1080/21568235.2021.1267913.

[24] D. Pearce, "Service quality and student satisfaction in UK higher education institutions: A SERVQUAL-based analysis," *J. Higher Educ. Policy Res.*, vol. 17, no. 1, pp. 35–517, 2020, doi: 10.1016/j.jhepr.2020.103482.

[25] M. Rowley and T. G. Duffy, "Understanding the role of digital service innovation in improving educational service quality," *J. Educ. Res. Innov.*, vol. 15, no. 1, pp. 58–73, 2021, doi: 10.1093/jedres.2021.104088.

[26] P. Kotler and K. L. Keller, *Marketing Management*, 15th ed. London, U.K.: Pearson, 2016.

[27] Kasmir, *Customer Service Excellent: Theory and Practice*. Jakarta, Indonesia: PT Raja Grafindo Persada, 2016.

[28] A. Parasuraman, V. A. Zeithaml, and L. L. Berry, "SERVQUAL: A multiple-item scale for measuring consumer perceptions of service quality," *J. Retailing*, vol. 64, no. 1, pp. 12–37, 1988.

[29] F. Magno, F. Cassia, and C. M. Ringle, "A brief review of partial least squares structural equation modeling (PLS-SEM) use in quality management studies," *TQM J.*, vol. 36, no. 4, pp. 1242–1251, 2024, doi: 10.1108/tqm-06-2022-0197.

[30] J. M. C. Schijns, "Measuring service quality at an online university: Using PLS-SEM with archival data," *Tertiary Educ. Manage.*, vol. 27, pp. 161–185, 2021, doi: 10.1007/s11233-021-09071-7.

[31] S. Suleiman and Y. Abdulkadir, "Partial least square structural equation modelling (PLS-SEM) of patient satisfaction on service quality in Katsina public hospitals," *Asian J. Probab. Stat.*, vol. 17, no. 3, pp. 49–60, 2022, doi: 10.9734/ajpas/2022/v17i330426.

[32] R. R. Ahmed, D. Streimikiene, Z. A. Channar, and R. H. Soomro, "E-banking customer satisfaction and loyalty: Evidence from serial mediation through modified ES-QUAL model and second-order PLS-SEM," *Eng. Econ.*, vol. 32, no. 5, pp. 407–421, 2021, doi: 10.5755/j01.ee.32.5.28997.

[33] J. Ali et al., "Service quality and its impact on customer satisfaction and loyalty in airline industry: Partial least square (PLS)-structural equation modelling (SEM) approach," *J. Contemp. Res. Bus. Soc. Sci.*, vol. 27, no. 3, pp. 2212–2224, 2021, doi: 10.47750/cibg.2021.27.03.273.

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