Journal of Information System and Technology Research

journal homepage: https://journal.aira.or.id/index.php/jistr/

Examining the Impact of Virtual Tour Service Quality on Visitor Satisfaction in Digital Museum Environments

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ARTICLE INFO

Article history:

Received Dec 4, 2025
Accepted Jan 28, 2026
Available online Jan 31, 2026

Keywords:

Virtual Museum,
Service Quality,
Digital Heritage,
User Engagement,
Visitor Satisfaction,
User Experience.

ABSTRACT (10 PT)

Research on virtual museums has expanded globally; however, empirical evidence from Indonesian digital cultural heritage institutions remains limited, particularly regarding how service quality shapes visitor satisfaction in fully virtual environments. Addressing this gap, this study investigates the influence of virtual tour service quality on visitor satisfaction at the Museum Kebangkitan Nasional, Indonesia, and examines the applicability of established service quality frameworks within a digital heritage context. Using a quantitative research design, data were collected through a structured survey from 97 users of the museum's virtual tour platform. Measurement instruments were adapted from SERVQUAL and e-SERVQUAL models, incorporating digital-specific dimensions such as interactivity, system usability, interface aesthetics, and accessibility. Data analysis employed descriptive statistics, correlation analysis, and multiple regression techniques. The results reveal that virtual tour service quality has a significant positive effect on visitor satisfaction, explaining 41.6% of the variance, with respondents reporting high levels of perceived service quality and overall satisfaction. These findings demonstrate the novelty of extending traditional service quality models to virtual museum environments, where technological performance and user interface design emerge as critical experiential determinants. Theoretically, the study contributes to service quality and digital heritage literature by validating hybrid service quality constructs in a virtual cultural setting. Practically, it provides actionable insights for museum managers and cultural institutions in Indonesia to enhance digital engagement through user-centered design, platform reliability, and continuous technological innovation.

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1. INTRODUCTION

The COVID-19 pandemic has catalyzed profound shifts in cultural heritage management globally, compelling museums to accelerate digital transformation to sustain engagement amid restricted physical access. In Indonesia, Large-Scale Social Restrictions (PSBB) intensified pre-existing challenges in museum management, including declining visitor numbers and limited digital strategies, highlighting a critical gap in empirical knowledge regarding how virtual service quality shapes visitor satisfaction in Indonesian museums. While international studies have examined virtual museum experiences and validated service quality models in digital heritage contexts, evidence from Indonesian institutions remains scarce, particularly regarding the integration of digital-specific dimensions such as interactivity, usability, and interface aesthetics. This research addresses this gap by investigating the influence of virtual tour service quality on visitor satisfaction at the Museum Kebangkitan Nasional, thereby providing theoretical validation of hybrid service quality frameworks in a Southeast Asian context and offering practical insights for enhancing digital engagement

strategies in emerging cultural heritage settings. [1] [2] [3]. International initiatives such as the European Digital Agenda [4] and Asia's online cultural participation strategies [5] indicate a long-term global shift toward digital-first cultural access, while in Asia, similar strategies emerged to democratize cultural participation via online platforms [6] [7]. These transformations signify a global realignment of museums toward digital-first engagement, suggesting a long-term shift in how cultural institutions operate.

In Indonesia, museums such as Museum Nasional Indonesia and the Museum Kebangkitan Nasional adopted virtual tours to maintain educational engagement during closures [8] [9]. These virtual initiatives expanded reach beyond geographical and physical constraints [10] and supported the national movement toward integrating digital culture within heritage management. This evolving context establishes the foundation for the present study.

The explicit research problem addressed in this study concerns the extent to which virtual museum service quality influences visitor satisfaction. As physical visits declined, museums needed to ensure that virtual alternatives provided meaningful engagement, effective learning outcomes, and satisfactory user experiences. The central research question is: Does virtual tour service quality significantly influence visitor satisfaction at the Museum Kebangkitan Nasional? This question responds directly to the need for empirical evidence on digital museum performance in Indonesia.

Aligned with this problem, the research objectives are explicitly defined as follows: (1) To measure visitor perceptions of virtual tour service quality; (2) To assess visitor satisfaction with the virtual tour experience; and (3) To analyze the influence of virtual tour service quality on visitor satisfaction at the Museum Kebangkitan Nasional. These objectives guide the structure of the study and anchor the analytical framework.

Previous studies emphasize the vital role of service quality in shaping satisfaction in digital environments. Virtual museum service quality includes dimensions such as system reliability, information richness, interactivity, and digital usability [11][12]. High service quality enhances immediate satisfaction, engagement, and intention to revisit [13]. Models such as SERVQUAL [14]. and the Information Systems Success Model [15] provide robust analytical tools for assessing these constructs.

Empirical studies consistently indicate that virtual museum experiences can elicit affective and cognitive outcomes comparable to physical visits, fostering exploration, self-directed learning, and emotional engagement when platforms are well-designed [16][17]. However, discrepancies exist: some studies report that poorly developed virtual interfaces compromise user satisfaction, highlighting the critical role of interactivity, navigational ease, and accessibility [18][19]. Comparative analyses further reveal both advantages and limitations of virtual tours relative to physical experiences. While virtual formats excel in flexibility, reach, and information delivery [20][21], they often fail to replicate the sensory immersion, social interaction, and emotional resonance characteristic of in-person visits [22][23]. These inconsistencies underscore unresolved questions regarding how digital service quality dimensions translate into perceived satisfaction across different cultural and technological contexts.

Despite substantial international evidence, empirical research on virtual museum performance in Indonesia remains scarce, particularly regarding the direct impact of service quality on visitor satisfaction. Existing literature does not fully address how hybrid service quality models—integrating classical relational dimensions with digital-specific factors such as interface aesthetics, usability, and accessibility—operate within Southeast Asian cultural settings. This study advances knowledge by quantitatively examining the relationship between virtual tour service quality and visitor satisfaction at the Museum Kebangkitan Nasional, thereby bridging the regional evidence gap. The study contributes in three key ways: (1) Theoretical: extending SERVQUAL and digital service quality frameworks to virtual heritage environments; (2) Empirical: providing data-driven insights into user engagement during crisis-induced digital transformations; (3) Practical: informing museum managers and policymakers on optimizing virtual design, accessibility, and overall user experience. By addressing unresolved issues in interface quality and cross-cultural applicability, this research positions Indonesian museums as hybrid cultural institutions operating across physical and digital domains, offering a model for enhancing digital cultural heritage management in the post-pandemic era.

2. RESEARCH METHOD

2.1 Type and Research Approach

This study employed a structured, quantitative research design using a survey method to investigate the relationship between virtual tour service quality and visitor satisfaction at the Museum Kebangkitan Nasional. The research process followed a systematic sequence of stages: (1) preparation, including topic selection, literature review, and instrument development; (2) data collection, through the distribution of questionnaires and compilation of responses; (3) data processing, involving editing, coding, and tabulation; (4) data analysis, applying statistical tools to test validity, reliability, and hypotheses; and (5) reporting, synthesizing findings and drawing conclusions. Each stage ensured methodological rigor and alignment with established quantitative research principles. The following are the research stages in figure 1

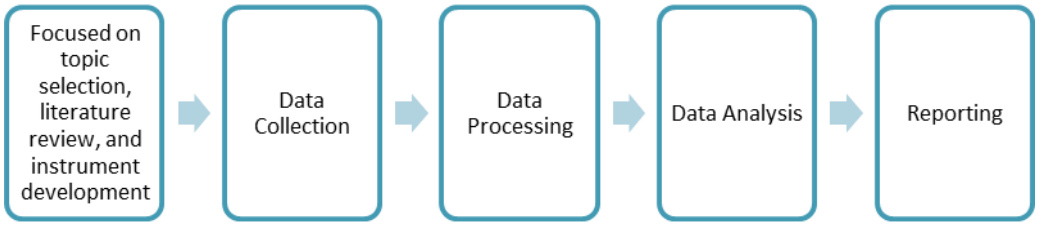

Figure 1. Research Stages

The study adapts SERVQUAL and e-SERVQUAL dimensions to the virtual museum context to measure service quality because these frameworks provide a validated, multidimensional approach for assessing perceived service excellence. Traditional SERVQUAL dimensions—reliability, responsiveness, assurance, empathy, and tangibility—capture core aspects of service delivery in physical settings. However, the transition to a digital environment necessitates additional considerations: interface usability, interactivity, digital aesthetics, and accessibility become critical determinants of user experience. By integrating these digital-specific dimensions, the study ensures that the measurement model accurately reflects the unique characteristics of virtual museum services, thereby enhancing construct validity and the relevance of findings for digital heritage management.

Cross-sectional data collection captured participants' perceptions at a single point in time, ensuring consistency and reliability of responses. This approach aligns with prior research in virtual tourism, which emphasizes quantification of perceptual constructs such as satisfaction and service quality [25] [26].

2.2 Population and Sample

The research population comprised all individuals who had accessed the Virtual Tour Museum Kebangkitan Nasional. A purposive sampling technique was employed to select 97 respondents who met the criterion of having experienced the virtual tour. The sample size was determined using Slovin's formula with a 10% precision level, appropriate for moderate-sized populations where exhaustive data collection is impractical. The purposive approach ensured inclusion of participants familiar with the virtual platform, thereby increasing the accuracy and relevance of responses. Selected respondents represented diverse demographic backgrounds, enhancing the contextual generalizability of the results. As noted by Strydom et al. (2020), purposive sampling is particularly suitable for studies requiring targeted insights from participants with specific experiential knowledge.

2.3 Research Location and Duration

2.3.1 Location

The research was conducted at the Museum Kebangkitan Nasional, located at Jl. Abdul Rahman Saleh No. 26, Senen District, Central Jakarta 10410. Data were gathered through both on-site visits and virtual platforms accessible via https://virtualtour.muskitnas.net/. The virtual museum platform served as the primary observation site, providing a digital context for assessing the quality of service delivery and user interaction. Conducting the study within the authentic operational environment of the museum's virtual tour ensured ecological validity and contextual accuracy. The research was conducted over a two-month period, encompassing both data collection and analysis phases. The research period officially commenced following the issuance of the institutional research permit. Table 1 presents the research schedule, illustrating the sequential implementation of each stage.

Table 1. Research Schedule

No	Activity	July	Aug	Sept	Oct	Nov	Dec
1	Preparation Phase (title submission, proposal)	✓					
2	Implementation Phase (data collection, analysis)		✓				
3	Report Compilation			✓			

2.4 Data Sources

2.4.1 Primary Data

Primary data were obtained directly from respondents via structured questionnaires distributed online and in person. The questionnaire captured individual perceptions of virtual tour service quality and overall satisfaction using a Likert-scale format. Each item was designed to elicit measurable responses aligned with the study's objectives. Such direct data collection ensures that responses reflect genuine user experiences and perceptions, which is critical for

examining subjective constructs like satisfaction [27]. The collected data thus provide the empirical foundation for testing the proposed hypothesis. Secondary data were collected from institutional records, including visitor statistics, administrative documentation, and published reports from the Museum Kebangkitan Nasional.

2.5 Research Instrument

The primary research instrument was a structured questionnaire employing a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The instrument was divided into two main sections: service quality (independent variable, X) and visitor satisfaction (dependent variable, Y). The Likert scale enables the quantification of subjective attitudes and perceptions, facilitating statistical analysis [28]. The measurement items were adapted from validated instruments, particularly SERVQUAL and e-SERVQUAL frameworks, which assess multiple service quality dimensionstangibility, reliability, responsiveness, assurance, empathy, and interactivity [27] [15]. Prior to data collection, the instrument underwent validity and reliability testing to ensure the precision and consistency of results. Cronbach's alpha values exceeding 0.7 confirmed internal reliability, consistent with standards in quantitative research [28].

Table 2. Likert Scale Assessment

Score	Category	Description
1	Strongly Disagree	Very low satisfaction
2	Disagree	Low satisfaction
3	Neutral	Moderate satisfaction
4	Agree	High satisfaction
5	Strongly Agree	Very high satisfaction

2.6 Data Collection Technique

Data collection was conducted through both online and on-site distribution of questionnaires. Respondents were requested to complete 16–20 structured items divided across dimensions of service quality and satisfaction. The use of self-administered questionnaires minimized interviewer bias and allowed respondents to reflect on their virtual experiences independently. Following Strydom et al. (2020), the structured survey design facilitates efficient data gathering and supports statistical generalization. Data were collected directly by the researcher to ensure authenticity and completeness.

2.7 Data Processing Technique

Data processing consisted of four sequential stages: editing, coding, tabulation, and data entry. Each completed questionnaire was reviewed for accuracy and completeness before being coded numerically. The coded data were entered into SPSS (Statistical Package for the Social Sciences) for analysis. Editing ensured data consistency, while tabulation organized responses into interpretable formats. Quantitative processing ensures objectivity and facilitates rigorous statistical testing, consistent with best practices in empirical social research [29].

2.8 Data Analysis Technique

Data analysis employed both descriptive and inferential statistical methods. Descriptive statistics summarized respondent demographics and general trends, while inferential analysis tested hypotheses regarding the relationship between virtual tour service quality and visitor satisfaction. The analysis sequence followed established quantitative protocols: validity testing using Pearson correlation, reliability testing using Cronbach's Alpha ($\alpha \geq 0.7$), and normality assessment via the Kolmogorov–Smirnov method. Linearity and heteroscedasticity tests were conducted to verify that data met the assumptions for regression analysis [27]. Subsequently, correlation analysis was used to determine the strength and direction of relationships, followed by regression analysis to quantify the predictive influence of service quality (X) on satisfaction (Y). The coefficient of determination (R^2) was calculated to measure the proportion of variance in satisfaction explained by service quality. Hypothesis validation was performed through F-tests and t-tests, identifying the statistical significance of the observed effects. Together, these analytical steps provide a comprehensive and methodologically robust framework for evaluating virtual tour service quality's impact on user satisfaction within digital cultural contexts.

3. RESULTS AND DISCUSSION

3.1 General Overview of the Research Site

The research was conducted at the Museum Kebangkitan Nasional, located at Jl. Abdul Rahman Saleh No. 26, Senen, Central Jakarta. This institution is one of Indonesia's most significant cultural heritage sites, dedicated to documenting the country's early nationalist movements and historical milestones. The museum operates under the Ministry of Education and Culture and features both physical and digital exhibits. During the COVID-19 pandemic, as physical visitation declined due to government-imposed restrictions, the museum shifted its public engagement strategy toward digitalization through its virtual tour platform (https://virtualtour.muskitnas.net/). This online system provided an

alternative avenue for visitors to access exhibitions interactively from remote locations. To contextualize the institutional structure supporting the digital transition Figure 1 illustrates the museum's organizational structure.

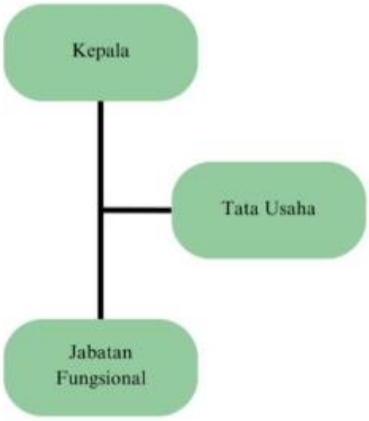

Figure 1. Organizational Structure

Figure 2 presents the homepage and navigation interface of the virtual tour, demonstrating how users begin the virtual journey, interpret menu labels, and move between exhibit rooms. The figure is intended to familiarize readers with the system's visual design and interactive features, which serve as the foundation for evaluating service quality in later analyses.

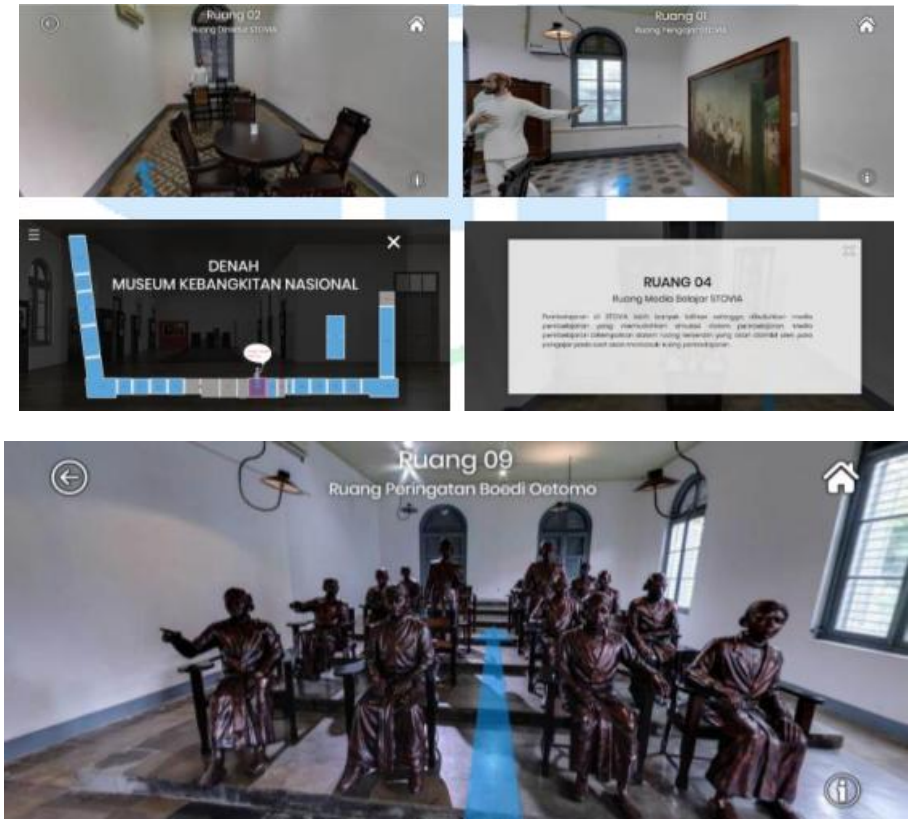

Figure 2. Interfaces

3.2 Respondent Demographics

The study involved 97 respondents who had experienced the museum's virtual tour. The gender distribution, as shown in Figure 3, illustrates the proportion of female and male participants, with 57.7% female and 42.3% male. The purpose of Figure 3 is to illustrate demographic balance, which is crucial for understanding perceptions of service quality across genders.

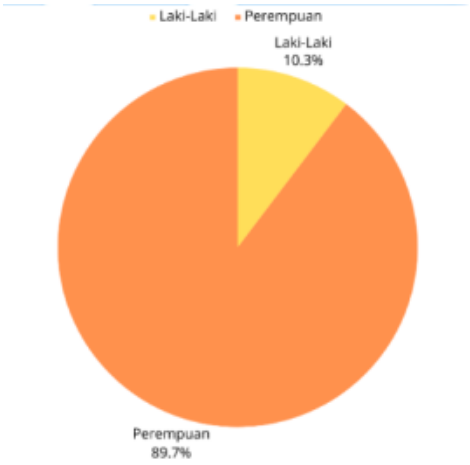

Figure 3. Gender Distribution

Figure 4 presents the age distribution, revealing that young adults aged 18–25 constituted the majority. This figure highlights that the virtual platform appeals strongly to digital-native audiences who are generally more receptive to technology [30] [31].

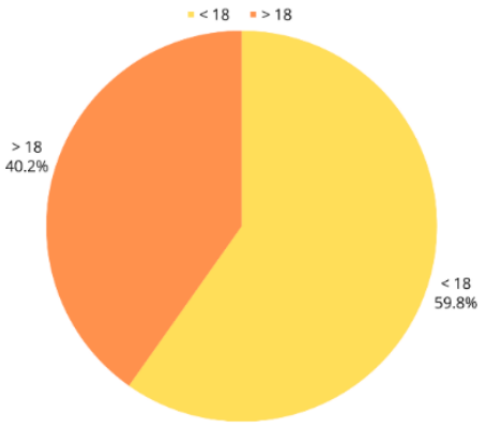

Figure 4. Age Distribution

Figure 5 displays respondents' occupations, demonstrating that students represent more than half of the sample. The objective of Figures 4 and 5 is to illustrate the technological affinity and academic motivations that shape users' satisfaction with virtual cultural services [32].

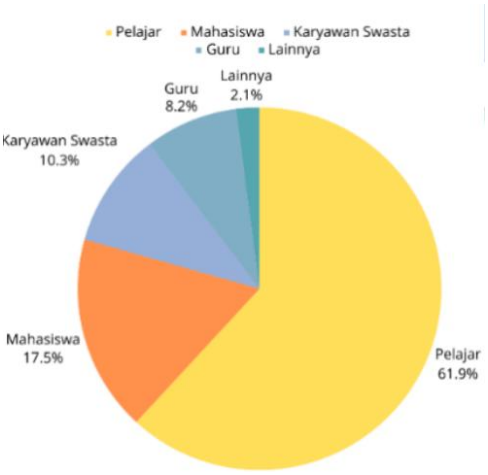

Figure 5. Work Distribution

3.3 Descriptive Statistics of Variables

3.3.1 Service Quality Variable (X)

Descriptive analysis generated an overall mean score of 3.07 for the service quality variable (X), indicating a high category according to the measurement scale. Table 3 provides a structured summary of each indicator's mean score, allowing readers to understand the relative strengths and weaknesses of the virtual tour's service performance. The highest score (3.42) reflects strong interest in using virtual museums for education, research, or recreation, demonstrating that the system meets users' informational expectations [12]. The lowest mean (2.27) pertains to the frequency of prior virtual museum visits, illustrating that although the experience is positively perceived, repeat visitation in digital contexts remains limited. Table 3 is designed to be read by interpreting each row as a dimension of perceived service quality, with the "mean" column showing respondents' ratings and the "category" indicating the qualitative interpretation of numerical scores.

Table 3. Descriptive Statistics of Service Quality (X)

Indicator	Mean	Category
Educational/research interest	3.42	Very High
System usability	3.15	High
Visual quality	3.10	High
Frequency of visits	2.27	Moderate
Average	**3.07**	**High**

These findings align with existing studies showing that content richness, usability, and interactivity strongly influence user satisfaction in virtual museum environments [33] [34].

3.3.2 User Satisfaction Variable (Y)

The mean satisfaction score was 3.23, categorized as high. Table 4 presents these values, with each indicator reflecting a different facet of satisfaction. The highest indicator (3.36) relates to recommendation willingness, indicating strong endorsement behavior driven by perceived efficiency and convenience. The lowest mean score (3.15) concerns revisit intention, suggesting that users may still prefer physical museum experiences for deeper emotional engagement [21] [35]. Table 4 should be read by comparing mean values to assess which aspects of satisfaction are strongest and which areas require improvement.

Table 4. Descriptive Statistics of User Satisfaction (Y)

Indicator	Mean	Category
Recommendation willingness	3.36	High
Perceived efficiency	3.28	High
Revisit intention	3.15	High
Average	**3.23**	**High**

3.4 Validity and Reliability Tests

Validity testing using Pearson correlations confirmed that all items exceeded the critical r-table threshold of 0.202, showing that each indicator adequately measures its intended construct. Reliability tests (Table 5) show Cronbach's Alpha values of 0.905 for service quality and 0.872 for satisfaction. Table 4.7 helps readers understand the internal consistency of the measurement items; higher alpha values indicate stronger reliability [28] [29].

Table 5. Reliability Statistics

Variable	Cronbach's Alpha	N of Items
Service Quality (X)	0.905	16
Satisfaction (Y)	0.872	6

3.5 Classical Assumption Tests

To ensure that regression analysis could be performed accurately, classical assumption tests were conducted. The normality test (Table 6) shows a Kolmogorov–Smirnov significance value of 0.200, indicating that the distribution is normal.

Table 6. Normality Test

One-Sample Kolmogorov-Smirnov Test		
		Unstandardized Residual
N		97
Normal Parameters[a,b]	Mean	,0000000
	Std. Deviation	1,95656810
Most Extreme Differences	Absolute	,080
	Positive	,058
	Negative	-,080
Test Statistic		,080
Asymp. Sig. (2-tailed)		,132[c]

Figures 4 visually support this conclusion by illustrating the histogram and P-P plot; their purpose is to help readers visually inspect whether the data follow a normal curve. The linearity test (Table 7) demonstrates a significant linear relationship between X and Y,

Table 7. Linearity Test

ANOVA Table							
			Sum of Square	df	Mean Square	F	Sig.
User Engagement Virtual Tour Museum	Between Groups	(Combined)	322,074	16	20,130	5,235	,000
		Linearity	262,167	1	262,167	68,185	,000
		Deviation from Linearity	59,908	15	3,994	1,039	,426
	Within Groups		307,596	80	3,845		
	Total		`629,670	96			

while the heteroscedasticity test (Table 8) confirms constant variance across residuals. These diagnostic tables collectively strengthen confidence in the validity of the regression output [27].

Table 8. Heteroscedasticity Test

Coeficients[a]						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constrant)	1,713	,967		1,771	,080
	Virtual Tour Museum	-,005	,031	-,017	-,168	867
a. Dependent Variable: RES2						

3.6 Regression Analysis

The regression equation Y = 11.329 + 0.482X quantifies the effect of service quality on satisfaction. This equation, when interpreted, means that each one-unit improvement in service quality contributes a 0.482-unit increase in satisfaction. Table 9 summarizes the regression coefficients, correlation values, and significance tests. The table should be read row-by-row: the constant represents baseline satisfaction; the coefficient (b) shows the magnitude of influence; R represents the correlation strength; R^2 represents explanatory power; and the F-test and t-test indicate overall and individual significance.

Table 9. Regression and Correlation Results

Parameter	Value	Interpretation
Constant (a)	11.329	Base satisfaction level
Coefficient (b)	0.482	Effect of service quality
R	0.645	Strong positive correlation

R^2	0.416	41.6% variance explained
F-test	68.117 (Sig. = 0.000)	Significant model
t-test	8.254 (Sig. = 0.000)	Significant positive effect

3.7 Summary of Key Findings

The findings demonstrate that virtual tour service quality is a significant determinant of visitor satisfaction at the Museum Kebangkitan Nasional, with the regression model explaining 41.6% of the variance. This effect size is comparable to several international studies on virtual museums, where service quality typically accounts for between 35% and 55% of satisfaction variance, depending on contextual and technological factors. While high mean scores indicate strong user approval of both service quality and satisfaction, the remaining 58.4% of unexplained variance highlights the multifaceted nature of virtual museum experiences [36] [37]. This residual variance suggests the influence of complementary factors beyond core service quality dimensions, including emotional engagement, depth of immersion, content relevance, individual motivation, and prior digital literacy. Consistent with international literature, these findings indicate that service quality functions as a foundational driver rather than a singular predictor of satisfaction, underscoring the need for more integrative explanatory models in virtual cultural heritage research. These insights align with broader literature emphasising the strategic potential of virtual museum experiences in strengthening cultural engagement, especially during periods of restricted physical access [38] [39].

Discussion

4.1 Theoretical Implications of Service Quality and Visitor Satisfaction

This study confirms that virtual tour service quality exerts a significant positive influence on visitor satisfaction at the Museum Kebangkitan Nasional, reinforcing the applicability of SERVQUAL and e-SERVQUAL frameworks within digitally mediated museum environments [12]. The obtained coefficient of determination ($R^2 = 0.416$) indicates a moderate-to-strong explanatory power, aligning with international findings that report effect sizes ranging from approximately 0.38 to 0.55 in virtual and hybrid museum contexts. For example, Forgas-Coll et al. (2017documented similar explanatory strength in digitally augmented museum services, while Rojas and Izquierdo (2008) [36] [37] demonstrated that perceived service quality remains a robust predictor of satisfaction even in non-physical cultural interactions.

Compared to studies reporting higher effect sizes—often exceeding 0.70 in technologically advanced settings—this study highlights the contextual sensitivity of service quality models. Scholars such as Kowalska and Ostręga (2020) and Shi (2025) emphasize that traditional SERVQUAL dimensions alone may be insufficient to fully capture digitally embedded experiences, particularly where interface aesthetics, navigational clarity, and system responsiveness become central experiential cues. The present findings thus support emerging theoretical arguments advocating hybridised service quality frameworks that integrate both classical relational dimensions and digital performance constructs to enhance explanatory completeness.

4.2 Demographic and Motivational Influences on Satisfaction

Demographic characteristics significantly shaped satisfaction outcomes, consistent with global research on virtual museum engagement [31]. Prior studies indicate that younger visitors typically report higher satisfaction due to greater technological familiarity and adaptive digital skills, a pattern clearly reflected in this study's dominant 18–25 age cohort. International evidence suggests that digital literacy operates as a mediating variable that amplifies perceived service quality and experiential value in virtual environments [32]. Motivational orientation further explains part of the unexplained variance observed in the regression model. Visitors motivated by educational and research purposes exhibited higher satisfaction levels, aligning with studies demonstrating that informational depth, interpretive clarity, and interactive learning features strengthen cognitive engagement. In contrast, recreationally motivated visitors placed greater emphasis on enjoyment, visual appeal, and experiential immersion. These findings indicate that satisfaction formation is contingent not only on service quality delivery but also on user intent, reinforcing the need for segmented experience design within virtual museums [40] [41].

4.3 Service Quality Dimensions and Their Impact on Satisfaction

The observed correlation coefficient ($r = 0.645$) confirms a strong positive association between service quality and visitor satisfaction, consistent with international benchmarks in virtual cultural heritage studies. Comparable studies similarly identified reliability, accessibility, and interface usability as central predictors of satisfaction in digital museum contexts. However, when contrasted with studies reporting higher R^2 values, the moderate explanatory power found here suggests that service quality alone does not fully encapsulate the experiential complexity of virtual museum visits. Argue that contextual factors such as technological infrastructure, cultural expectations, and familiarity with digital platforms significantly moderate satisfaction outcomes. Accordingly, the unexplained variance in this study should be interpreted not as a limitation, but as empirical evidence of the multidimensional and context-dependent nature of virtual cultural experiences, particularly within Southeast Asian settings [36].

4.4 Comparative Reflections: Virtual versus Physical Museum Experiences

Comparative analysis with prior international research reveals both continuity and divergence in satisfaction determinants across physical and virtual museum environments [42] [43]. While traditional service quality dimensions such as responsiveness and empathy remain relevant, virtual contexts introduce additional determinants most notably interactivity, accessibility, and interface aesthetics that have no direct physical equivalents [44]. demonstrate that interactivity and visual quality compensate for the absence of physical tangibility by fostering emotional and cognitive immersion. Similarly, enhanced accessibility in virtual museums broadens inclusivity, echoing findings. The alignment of this study's results with international patterns suggests that Indonesian virtual museum users share global expectations regarding usability, immersion, and aesthetic quality, reinforcing the cross-cultural relevance of digital service quality constructs.

4.5 Managerial Implications for Digital Museum Practice

From a managerial perspective, the findings emphasize that service quality improvements yield substantial but not exhaustive gains in visitor satisfaction. International best practices indicate that continuous platform refinement, adaptive interface design, and content diversification are necessary to address the unexplained components of visitor experience. The Museum Kebangkitan Nasional's performance reflects global evidence that digitalization enhances institutional resilience by expanding reach and sustaining engagement beyond physical constraints [45][46]. Comparative studies further suggest that iterative digital development strategies rather than one-time technological adoption—are critical for long-term satisfaction. These insights underscore the importance of integrating user feedback mechanisms and analytics-driven decision-making to capture experiential dimensions not fully explained by traditional service quality metrics.

4.6 Integration of Immersive Technologies and Future Prospects

International research consistently demonstrates that immersive technologies such as augmented reality (AR) and virtual reality (VR) substantially increase explanatory power in visitor satisfaction models by capturing emotional and experiential depth [45] [46] [47]. Studies by Piccardi et al. (2025) and Cappa et al. (2020) show that immersive interaction enhances cognitive engagement and affective response, thereby addressing variance unexplained by conventional service quality constructs [48].

Within the Indonesian context, the potential adoption of immersive technologies by the Museum Kebangkitan Nasional aligns with global movements toward hybrid and fully virtual heritage experiences [49] [50]. Empirical evidence suggests that such technologies not only enhance satisfaction but also support cultural sustainability by expanding inclusivity and remote participation [51]

4.7 Broader Implications for Cultural Heritage Management

This study contributes to a growing international discourse that positions digital service quality as a foundational—but partial—pillar of contemporary cultural heritage management. Comparative studies across Europe and Asia reveal similar patterns, where digital transformation strengthens institutional adaptability while simultaneously introducing new experiential variables. By situating the Museum Kebangkitan Nasional within this global context, the findings illustrate how virtual museums increasingly function as dynamic platforms for cultural engagement rather than mere substitutes for physical visitation.

4. CONCLUSION

This study confirms that virtual tour service quality exerts a significant positive influence on visitor satisfaction at the Museum Kebangkitan Nasional, explaining 41.6% of the observed variance. The findings reaffirm the relevance of SERVQUAL and e-SERVQUAL frameworks in virtual cultural heritage settings, while demonstrating that digital-specific dimensions—particularly interactivity, system usability, interface aesthetics, and accessibility—are central determinants of satisfaction in technology-mediated museum experiences. Beyond validating service quality theory in a digital heritage context, this study highlights how technological performance and user-centered design function as core experiential drivers when physical access is constrained. From a managerial standpoint, the results underscore the strategic importance of investing in reliable platforms, adaptive interface design, and continuous digital innovation to sustain engagement and learning outcomes. Methodologically, future research is strongly encouraged to adopt longitudinal designs to capture changes in visitor perceptions over time, as well as to integrate emerging immersive technologies—such as augmented reality (AR), virtual reality (VR), and 360° interactive environments—to assess deeper forms of technological immersion and affective engagement. Additionally, cross-cultural and comparative studies across museums may further refine theoretical models of virtual museum satisfaction. Overall, this study contributes to digital transformation scholarship in cultural heritage management by offering both theoretical validation and forward-looking methodological directions for advancing high-quality virtual museum experiences.

5. ACKNOWLEDGEMENTS

The authors would like to express their sincere gratitude to the management of the Museum Kebangkitan Nasional, Indonesia, for granting permission and providing valuable support during the data collection process. Special appreciation is extended to all respondents who participated in this study and contributed their time and honest feedback, which made this research possible. The authors also acknowledge the Faculty of Computing and Meta Technology, Sultan Idris Education University (UPSI), Malaysia, and the Faculty of Computing and Digital Intelligence, Universitas Pembangunan Panca Budi, Medan, Indonesia, for their academic guidance and institutional support throughout the research. Finally, the authors would like to thank colleagues, friends, and family members for their continuous encouragement and moral support during the completion of this scientific work.

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