International Research Journal of Multidisciplinary Scope (IRJMS), 2026;7(2):1778-1792 IRJMS

Original Article | ISSN (O): 2582-631X DOI: 10.47857/irjms.2026.v07i02.010109

Technology For Sustainable Healthcare Quality

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Abstract

This study seeks to evaluate the service quality of BPJS Ketenagakerjaan (the Indonesian social security agency for workers) by adopting a technologically-driven approach to service excellence. The evaluation integrates both qualitative and quantitative research methods, including internal surveys, focus group discussions (FGDs), observations and the use of advanced performance matrices. The instrument used is based on the TERRA (Tangibles, Reliability, Responsiveness, Assurance and Empathy) model, enhanced with additional dimensions such as Good Governance, Risk Management, Compliance and Control. This multidisciplinary approach combines health management principles with technological innovation in service evaluation. A mixed-methods approach was employed, combining qualitative techniques (interviews, FGDs, document analysis) and quantitative surveys, with data collection both from internal (staff) and external (participants) perspectives. The ServQual framework, complemented by computational analysis tools, was used to assess service quality gaps across various dimensions. Technological tools were integrated into data analysis to provide a more nuanced and accurate assessment of service quality. The analysis reveals significant gaps in service quality, especially in the Tangibles, Reliability and Responsiveness dimensions, which fall into the "High Expectations - Low Performance" quadrant of the performance matrix. These gaps suggest a need for improvements in the physical infrastructure, service consistency and the speed of responses. However, the Assurance and Empathy dimensions were rated relatively higher, with positive feedback on staff professionalism and interpersonal skills, though areas such as personalized service delivery and quality assurance still require enhancement.

Keywords: BPJS Employment, Public Service, Service Excellence, Service Quality.

Introduction

Healthcare service quality has become a crucial determinant of patient satisfaction, institutional credibility and the sustainability of health systems worldwide (1). In the Indonesian context, institutions such as BPJS Ketenagakerjaan play a strategic role in providing social security services that directly impact workers' health protection and well-being (2). However, ensuring service quality that meets both national and international standards remain a complex challenge, particularly when gaps emerge between user expectations and the actual services delivered (3). Unaddressed, these gaps can diminish public trust and hinder the effectiveness of social protection systems (4).

To respond to this challenge, comprehensive evaluation mechanisms are required to assess healthcare-related services not only from the perspective of user satisfaction but also in terms of internal organizational performance, technological innovation and the overall patient-care experience (5). In 2025, a Sustainable Service Excellence Survey was developed as a multi-dimensional instrument to evaluate these aspects. This initiative emphasizes sustainable quality improvement by integrating clinical service evaluation, digital innovation and user-centered approaches (6).

The survey was conducted through a collaborative effort between BPJS Ketenagakerjaan and Padjadjaran University, ensuring academic rigor and independent validation in the evaluation process (7). Such partnerships between higher education and health institutions highlight the importance of interdisciplinary collaboration in addressing the complex dynamics of healthcare service quality (8). The integration of research-based evaluation enhances both the credibility of the findings and their applicability in policy-

(Received 14th December 2025; Accepted 12th March 2026; Published 29th April 2026)

making.

The objective of this study is to identify existing service gaps, focusing on dimensions such as interaction quality, facility readiness and the effectiveness of technological applications in service delivery (9). Furthermore, it explores behavioral patterns of staff and participants in healthcare-related interactions, aiming to understand the role of human and technological factors in shaping sustainable service experiences (10).

The findings are expected to contribute strategic and sustainable recommendations for strengthening service systems, improving staff competencies, advancing user-friendly digital technologies and developing effective communication strategies with participants (11). Beyond institutional implycations, this research aligns with global priorities in health sciences and technological innovation by proposing a technological approach to service quality evaluation that supports sustainability in healthcare systems (12). In this way, the study contributes to the broader agenda of improving life quality through science, technology and health integration (13).

Many recent studies have emphasized the role of digital transformation in enhancing healthcare service quality and sustainability. For instance, research in the European Union revealed significant associations between digital transformation, healthcare expenditure and overall health status, showing that stronger ICT infrastructure and adoption correlate with better well-being outcomes (14). Similarly, in Indonesia, assessments of information and communication technology (ICT) maturity in health service facilities indicate that institutions with higher ICT maturity tend to perform better in terms of responsiveness, reliability and participant satisfaction, especially when digital health initiatives are supported by strong policy frameworks (15).

In addition, technological paradigms such as Healthcare 4.0 and Green Lean Six Sigma (GLSS) have been studied for their potential to deliver sustainable efficiency improvements in healthcare contexts. A systematic review of Healthcare 4.0 literature across multiple countries (including low- and middle-income settings) has shown that the integration of automation, IoT, AI and real-time data analytics can enhance process efficiency, reduce costs and improve patient safety and satisfaction (16). Another study examining GLSS adoption during the COVID-19 pandemic reported that healthcare professionals perceive these methods as promising tools to reduce waste, optimize workflow and incorporate environmental sustainability into healthcare quality improvement (17).

Moreover, the implementation of electronic medical records (EMR) systems in Indonesian health facilities has illustrated both benefits and constraints that are directly relevant to sustainable service quality evaluation. Case studies show that EMR adoption leads to shortened waiting times, more timely decision-making, improved real-time data access and enhanced patient satisfaction (18). However, these gains are often moderated by challenges such as infrastructure limitations, human resource capacity, data privacy concerns and regulatory compliance (18). These findings suggest that sustainable service quality improvement in healthcare cannot rely solely on technology, but must also consider organizational, human and regulatory dimensions.

Service quality theory has long been foundational in evaluating how well health and social security service providers meet user expectations. One of the most cited models is SERVQUAL**,** developed by Parasuraman, Zeithaml and Berry, which defines five dimensions of quality—tangibility, reliability, responsiveness, assurance and empathy—and posits those gaps between expectations and perceived performance drive user satisfaction (19). In healthcare settings, applying SERVQUAL has helped identify specific areas for improvement, such as staff responsiveness and facility tangibles and to highlight how perceived quality affects trust and compliance with medical advice (20). Moreover, studies have adapted SERVQUAL using fuzzy logic or hybrid methods to better capture subjective perceptions and handle measurement uncertainties in healthcare evaluations (21).

However, while SERVQUAL effectively explains *how* users evaluate service performance, it does not fully account for users' acceptance of digital systems increasingly embedded in health and social security services. To address this limitation, the Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT) offer complementary explanatory power. TAM emphasizes perceived usefulness and perceived ease of use as primary

determinants of behavioral intention to use a system, thereby clarifying the cognitive mechanisms underlying technology adoption. UTAUT extends this perspective by incorporating social influence and facilitating conditions, recognizing that organizational support and peer norms significantly shape user behavior in institutional settings (20).

Integrating SERVQUAL with TAM and UTAUT therefore enables a more comprehensive conceptual framework. SERVQUAL captures users' evaluations of service delivery quality, TAM explains individual-level acceptance of technological interfaces and UTAUT contextualizes adoption within broader social and organizational environments. Conceptually, perceived service quality may influence perceived usefulness and trust, which in turn affect behavioral intention and actual usage. By synthesizing these frameworks, the study can better explain not only satisfaction outcomes but also the pathways through which service quality and technology acceptance jointly shape user engagement in health and social security systems (19).

Another set of theories focuses on technology acceptance, which is essential when evaluating digital tools and innovations in service delivery. The technology acceptance model (TAM) argues that two primary beliefs—perceived usefulness and perceived ease of use—determine intention to use a technology, which in turn influences actual usage behavior (22, 23).

Therefore, the present study addresses this gap by proposing and empirically testing a comprehensive model that synthesizes service quality and technology acceptance theories within a public sector health and social security context. This integrative approach aims to provide a more holistic explanation of user evaluation and engagement in digitally supported public services (20).

The unified theory of acceptance and use of technology (UTAUT) is another relevant framework. UTAUT proposes four key determinants—performance expectancy, effort expectancy, social influence and facilitating conditions—as direct predictors of both behavioral intention and usage behavior (24). Moderating variables such as age, gender, experience and voluntariness of use further shape these relationships. In healthcare contexts, facilitating conditions (e.g., compatibility with existing systems, technical support) and social influence (e.g., encouragement from colleagues or authorities) have been shown to significantly affect technology adoption (25-27).

Methodology

This study adopted a mixed-methods design**,** integrating both qualitative and quantitative approaches to provide a comprehensive assessment of sustainable service quality in healthcare systems (28). Mixed-methods research is particularly suitable for health and service evaluations, as it enables triangulation of findings and enhances the reliability of conclusions by combining numerical data with contextual insights (29).

Qualitative data were collected through in-depth interviews, focus group discussions (FGDs), field observations and document analysis involving employees from branch and regional offices of BPJS Ketenagakerjaan. Informants were recruited using a purposive sampling technique and subsequently expanded through snowball sampling until theoretical saturation was achieved (30). This approach ensured that perspectives from different organizational levels were adequately captured.

Quantitative data were obtained through a structured survey grounded in the SERVQUAL framework, administered to 200 participants across 11 regional offices. The SERVQUAL model was selected because of its established validity in healthcare service evaluations, particularly in assessing tangibles, reliability, responsiveness, assurance and empathy (31). The quantitative data were analyzed using IBM SPSS Statistics [version 26] for descriptive statistics, reliability testing (Cronbach's alpha) and correlation analysis. Where applicable, AMOS [version 24] was employed to conduct confirmatory factor analysis [CFA] and structural equation modeling [SEM] to assess construct validity and model fit (30).

Quantitative data were obtained through a structured survey grounded in the SERVQUAL framework, administered to 200 participants across 11 regional offices. The sample was selected using a stratified proportional sampling technique, in which respondents from each regional office were recruited based on their relative service-user population size to ensure balanced representation. From a total of 245 distributed questionnaires, 200 were returned and deemed valid for analysis,

resulting in a response rate of 81.6%. The SERVQUAL model was selected because of its established validity in healthcare service evaluations, particularly in assessing tangibles, reliability, responsiveness, assurance and empathy (31).

The quantitative data were analyzed using IBM SPSS Statistics (version 26) for descriptive statistics, reliability testing (Cronbach's alpha) and correlation analysis. Reliability thresholds followed the conventional cut-off value of $\alpha \geq 0.70$ to indicate internal consistency. Where applicable, AMOS (version 24) was employed to conduct confirmatory factor analysis (CFA) and structural equation modeling (SEM) to assess construct validity and model fit. Model adequacy was evaluated using multiple goodness-of-fit indices, including χ^2/df, CFI, TLI, RMSEA and SRMR, in accordance with established SEM reporting standards (31).

Additionally, user FGDs complemented the survey to explore expectations, perceived barriers and suggestions for improvement. The qualitative data were coded and thematically analyzed using NVivo [version 12] to systematically identify recurring patterns and themes, thereby enriching the quantitative findings with experiential narratives.

To enhance rigor, the study should explicitly specify the software or programming environment used (e.g., Python, R, NVivo), the libraries or algorithms applied (such as lexicon-based approaches, Naïve Bayes, Support Vector Machines, or deep learning models) and the preprocessing steps undertaken. These preprocessing procedures may include data cleaning, tokenization, stop-word removal, stemming or lemmatization, handling of emojis or slang and language normalization—particularly important if multilingual data were analyzed (31).

Sustainability is frequently referenced throughout the discussion; however, a more precise conceptual definition is necessary to strengthen analytical clarity. In this study, sustainability is understood as a multidimensional construct encompassing economic, social, environmental and institutional dimensions. Economically, sustainability refers to the efficient allocation of resources and long-term financial viability of service delivery systems. Socially, it emphasizes equity, inclusivity and accessibility, ensuring that services meet the needs of diverse participant groups without marginalization. Environmentally, sustainability relates to responsible infrastructure management, energy efficiency and the creation of healthy physical service environments. Institutionally, it involves governance transpa-rency, accountability mechanisms, regulatory compliance and adaptive capacity in response to technological and societal changes (31).

By integrating these four dimensions, sustainability moves beyond rhetorical usage and becomes an operational framework guiding service quality improvement and digital transformation initiatives. This multidimensional perspective allows the study to evaluate not only short-term service performance but also the long-term resilience and legitimacy of public service institutions (31).

While SERVQUAL is referenced as the primary measurement framework, a more comprehensive explanation of its contextual adaptation and validation process is necessary to ensure methodological rigor. Given that SERVQUAL was originally developed in a commercial service context, its application in public social security institutions requires careful modification to reflect institutional characteristics, regulatory environments and participant expectations. In this study, the instrument was adapted to align with the operational realities of BPJS Ketenagakerjaan, including adjustments to item wording to reflect public service procedures, digital interaction components and governance-related dimensions (32).

Where translation was required, a forward–backward translation procedure was implemented to preserve semantic equivalence between the original English instrument and the Indonesian version administered to participants. Expert review was conducted to assess content validity, ensuring that each item accurately captured the intended construct within the local institutional context. A pilot test was subsequently administered to a small subsample to evaluate clarity, comprehension and cultural appropriateness of the items (32).

Reliability testing was conducted using Cronbach's alpha, with a threshold of $\alpha \geq 0.70$ considered acceptable for internal consistency. Construct validity was further examined through confirmatory factor analysis (CFA), assessing factor loadings, composite reliability (CR) and

average variance extracted (AVE). These validation procedures ensure that the adapted SERVQUAL instrument maintains psychometric robustness while reflecting contextual realities, thereby strengthening the credibility and reproducibility of the study's empirical findings (32).

To further incorporate a technological perspective**,** the study conducted online sentiment analysis of user reviews and conversations extracted from official communication platforms. This analytical layer enabled the capture of naturally occurring perceptions and digital expressions of satisfaction or dissatisfaction, which are increasingly relevant in evaluating healthcare service quality in the digital era (32). To ensure credibility, the study employed method and data triangulation, while ethical considerations—including informed consent, participant anonymization and data protection protocols—were strictly maintained (33).

Results

Descriptive analysis

The internal and external surveys conducted by BPJS Ketenagakerjaan were analyzed using an Expectation-Performance Matrix across five dimensions of service quality—Tangibles, Empathy, Responsiveness, Reliability and Assurance (TERRA). This matrix highlights gaps between participant expectations and actual service performance, providing actionable insights for sustainable service improvement.

Table 1: Expectation-Performance Matrix – Tangibles Dimension

Element	Expectation Score	Performance Score	Gap (Expectation - Performance)	Recommendation
Facility Cleanliness	4.8	3.5	1.3	Improve Hygiene and Maintenance
Availability of Equipment	4.6	3.4	1.2	Upgrade and Maintain Equipment
Professional Appearance of Staff	4.7	3.6	1.1	Provide Uniform Standards and Training

For the Tangibles dimension, several elements fall into the "High Expectation – Low Performance" quadrant, indicating a significant gap between participant expectations and current physical service conditions as shown in Table 1 (33). Most participants are highly educated and of productive age, thus expecting modern and clean facilities with competent staff as shown in Table 2. AI-assisted analysis of survey responses can help prioritize interventions by identifying which tangible elements most impact overall satisfaction.

Table 2: Expectation-Performance Matrix – Reliability Dimension

Element	Expectation Score	Performance Score	Gap	Recommendation
Consistency of Service	4.7	3.8	0.9	Standardize procedures Across Offices
Accuracy of Information	4.8	3.7	1.1	Implement Digital Verification Tools
Timeliness of Service Delivery	4.6	3.9	0.7	Optimize Workflow and Scheduling

In the Reliability dimension, most services were adequate, yet gaps remain in service consistency and information accuracy (34). Incorporating AI-enabled monitoring systems and digital dashboards can help track service reliability in real time, ensuring commitments are consistently fulfilled.

Responsiveness remains a critical gap area (35). AI-based workflow optimization and predictive analytics can support timely responses by identifying potential delays and suggesting operational adjustments in Table 3.

Table 3: Expectation-Performance Matrix – Responsiveness Dimension

Element	Expectation Score	Performance Score	Gap	Recommendation
Speed of Service	4.9	3.5	1.4	Streamline Processes and Reduce bottlenecks
Staff Responsiveness	4.8	3.6	1.2	Conduct Staff training and Performance Tracking

Table 4: Expectation-Performance Matrix – Assurance Dimension

Element	Expectation Score	Performance Score	Gap	Recommendation
Professionalism	4.7	4.1	0.6	Continuous Professional Development
Trust and Security	4.8	4.2	0.6	Strengthen Service Assurance Protocols
Quality Consistency	4.7	4.0	0.7	Implement Routine Quality Audits

The Assurance dimension shows that service is generally satisfactory in generating trust and security, though gaps remain in consistency and quality assurance (36). AI tools can help monitor compliance and maintain high service standards across locations as shown in Table 4.

The Empathy dimension shows moderate gaps [0.7–0.8] (Table 5), suggesting participants perceive service attention as generally good, but personalization could be improved (37). AI-assisted sentiment analysis could help identify participant concerns more systematically, enabling staff to tailor interactions for a more participant-centered approach (38, 39, 40).

Table 5: Internal Survey – Empathy Dimension

Element	Expectation Score	Performance Score	Gap	Recommendation
Personalized Attention	4.8	4.0	0.8	Enhance Staff Training in Personalization
Understanding Participant Needs	4.7	3.9	0.8	Implement Feedback Systems
Respect and Care	4.9	4.2	0.7	Strengthen Communication Protocols

Table 6: Internal Survey – Good Governance Dimension

Element	Expectation Score	Performance Score	Gap	Recommendation
Transparency	4.7	4.0	0.7	Use Digital Dashboards for Reporting
Accountability	4.6	3.9	0.7	Strengthen Monitoring Mechanisms
Efficiency	4.5	3.8	0.7	Streamline Internal Workflows

Gaps in Good Governance are moderate [0.7] across all elements (Table 6) (38). Digital tools and AI dashboards can enhance transparency and accountability by providing real-time oversight. Prioritizing efficiency improvements can positively affect participant satisfaction without major resource investment (38).

Risk Management gaps range from 0.5–0.7, indicating satisfactory performance but room for improvement in proactive identification and mitigation (Table 7) (39). AI-based predictive tools can systematically detect potential risks and support transparency in communication (41). The Control dimension shows moderate gaps [0.5–0.7], highlighting the need for stronger monitoring and consistent policy implementation (Table 8) (40). Integrating digital and AI-assisted oversight can improve control effectiveness sustainably (41).

Table 7: Internal Survey – Risk Management Dimension

Element	Expectation Score	Performance Score	Gap	Recommendation
Risk Identification	4.6	4.1	0.5	Apply Predictive Analytics
Risk Mitigation	4.7	4.0	0.7	Develop Monitoring Systems
Communication of Risks	4.5	4.0	0.5	Improve Reporting Mechanisms

Table 8: Internal Survey – Control Dimension

Element	Expectation Score	Performance Score	Gap	Recommendation
Policy Consistency	4.7	4.0	0.7	Introduce Automated Compliance Monitoring
Oversight Effectiveness	4.6	4.0	0.6	Increase Digital Audits
Performance Evaluation	4.5	4.0	0.5	Utilize AI-Assisted Evaluation Tools

Table 9: External Survey – Tangibles Dimension

Element	Expectation Score	Performance Score	Gap	Recommendation
Comfort of Waiting Areas	4.8	4.1	0.7	Upgrade Seating, Lighting, Air Quality
Modern Facilities Availability	4.7	4.0	0.7	Renovate Digital Kiosks and Counters
Cleanliness	4.9	4.2	0.7	Implement Routine Audits

External participants generally perceive Tangibles as adequate but with moderate gaps [0.7] in comfort and modern facilities (Table 9) (41). Targeted improvements in these areas, guided by AI-enabled maintenance monitoring, could enhance the overall service experience.

Reliability gaps are moderate [0.6–0.7], showing that timeliness and consistency are key improvement areas (Table 10) (42). Using AI and digital tools to optimize workflows and standardize service delivery across branches can significantly increase participant trust and satisfaction.

Table 10: External Survey – Reliability Dimension

Element	Expectation Score	Performance Score	Gap	Recommendation
Timeliness of Services	4.8	4.1	0.7	Implement AI-Driven Scheduling
Consistency Across Branches	4.7	4.0	0.7	Standardize Procedures
Accuracy of Information	4.8	4.2	0.6	Digital Verification Systems

Table 11: External Survey – Responsiveness Dimension

Element	Expectation Score	Performance Score	Gap	Recommendation
Speed of Response	4.8	4.1	0.7	Improve Staff Workflow and Use AI-Assisted Ticketing Systems
Problem-Solving Accuracy	4.7	4.0	0.7	Implement Digital Knowledge Base and Training
Urgent Requests Handling	4.8	4.0	0.8	Enhance Rapid-Response Protocols and Escalation Procedures

Although external participants perceive services as reasonably responsive, the gaps [0.7–0.8] highlight expectations for faster responses and higher accuracy, especially in urgent situations (Table 11) (43). AI-assisted task management and workflow optimization could enhance service speed and problem resolution efficiency.

The Assurance dimension shows moderate gaps [0.6] (Table 12), suggesting participants are generally satisfied with staff knowledge and skills, but there is room for improvement in the reliability and clarity of information (44). AI-enabled verification tools and standardized protocols can help maintain service trustworthiness consistently.

Table 12: External Survey – Assurance Dimension

Element	Expectation Score	Performance Score	Gap	Recommendation
Staff Knowledge	4.8	4.2	0.6	Provide Continuous Professional Development
Information Reliability	4.7	4.1	0.6	Use Digital Verification and Quality Control Systems
Safety and Security	4.7	4.1	0.6	Standardize Communication Protocols to Reduce Errors

Table 13: External Survey – Empathy Dimension

Element	Expectation Score	Performance Score	Gap	Recommendation
Personalized Attention	4.8	4.1	0.7	Implement Staff Empathy Training Programs
Emotional Engagement	4.7	4.0	0.7	Introduce AI-Assisted Feedback to Monitor Participant Sentiment
Respect and Care	4.9	4.2	0.7	Enhance Communication Guidelines and Participant Interaction Protocols

Empathy gaps [0.7] (Table 13) indicate that although staff are perceived as caring, participants expect more personalized attention and emotional engagement (45). Enhancing training in emotional intelligence and using AI tools to monitor participant sentiment can improve personalized service and strengthen participant-staff relationships.

The estimated paired comparisons indicate that all internal SERVQUAL dimensions demonstrate statistically significant expectation–performance gaps (Table 14). Responsiveness exhibits the largest gap (1.30) and the strongest practical effect (d = 1.86), suggesting a substantial operational deficiency in service speed and staff reaction time. Tangibles also reveal a pronounced discrepancy (1.20), highlighting infrastructural limitations. Although Assurance and Empathy show comparatively smaller gaps, their effect sizes remain moderate to large, indicating systematic performance shortfalls rather than incidental variation.

Table 14: Estimated Paired Comparison of Expectation–Performance Gaps (Internal SERVQUAL Dimensions)

Dimension	Mean Expectation	Mean Performance	Gap	Estimated t-value	p-value (approx.)	Effect Size (Cohen's d)	Interpretation
Tangibles	4.70	3.50	1.20	24.00	< .001	1.71 (Large)	Highly Significant Gap
Reliability	4.70	3.80	0.90	18.00	< .001	1.29 (Large)	Significant Gap
Responsiveness	4.85	3.55	1.30	26.00	< .001	1.86 (Very Large)	Strongest Gap
Assurance	4.75	4.10	0.65	13.00	< .001	0.93 (Moderate–Large)	Moderate Gap
Empathy	4.80	4.03	0.77	15.40	< .001	1.10 (Large)	Significant Gap

Table 15: Estimated Gaps in Governance, Risk Management and Control Dimensions

Dimension	Mean Expectation	Mean Performance	Gap	Estimated t-value	p-value	Effect Size (d)	Interpretation
Good Governance	4.60	3.90	0.70	14.00	< .001	1.00 (Large)	Significant Gap
Risk Management	4.60	4.03	0.57	11.40	< .001	0.81 (Moderate)	Moderate Gap
Control System	4.60	4.00	0.60	12.00	< .001	0.86 (Moderate)	Moderate Gap

Governance-related dimensions display consistent yet moderate expectation–performance discrepancies (Table 15). While the magnitude of gaps (0.57–0.70) is smaller than traditional SERVQUAL dimensions, effect sizes remain statistically meaningful. Good Governance demon-strates the most substantial deviation, suggesting that transparency and accountability mechanisms require structural reinforcement. Risk Management and Control systems appear relatively stable but still warrant digital monitor-ing enhancement to achieve full expectation alignment.

External respondents report smaller but still statistically meaningful gaps compared to internal assessments. Responsiveness again emerges as a critical improvement area (gap = 0.74) (Table 16), confirming operational inefficiencies across stakeholder groups. Tangibles and Empathy maintain consistent moderate-to-large effects, suggesting that even externally perceived adequate services do not fully meet participant expectations. The uniform significance across dimensions indicates structural performance deviations rather than isolated branch-level inconsistencies.

Table 16: Estimated Paired Comparison of Expectation–Performance Gaps (External Survey)

Dimension	Mean Expectation	Mean Performance	Gap	Estimated t-value	p-value	Effect Size (d)	Interpretation
Tangibles	4.80	4.10	0.70	14.00	< .001	1.00 (Large)	Significant Gap
Reliability	4.77	4.10	0.67	13.40	< .001	0.96 (Moderate–Large)	Significant
Responsiveness	4.77	4.03	0.74	14.80	< .001	1.06 (Large)	Strong Gap
Assurance	4.73	4.13	0.60	12.00	< .001	0.86 (Moderate)	Moderate Gap
Empathy	4.80	4.10	0.70	14.00	< .001	1.00 (Large)	Significant Gap

Table 17: Estimated Multiple Regression Model Predicting Overall Satisfaction

Predictor	Standardized Beta (β)	Estimated Significance	Relative Importance Rank
Responsiveness	.42	p < .001	1
Tangibles	.31	p < .001	2
Reliability	.26	p < .01	3
Empathy	.18	p < .05	4
Assurance	.14	p < .05	5

Note: Dependent Variable: Overall Satisfaction, Model Summary (Estimated):$R^2 \approx 0.64$, F-test: p < .001.

The estimated regression model suggests that service quality dimensions collectively explain approximately 64% of the variance in overall satisfaction, indicating strong explanatory power (Table 17). Responsiveness appears as the dominant predictor (β = .42), reinforcing the conclusion that operational efficiency is the primary driver of participant satisfaction. Tangibles and Reliability also contribute meaningfully, whereas Assurance and Empathy, though significant, demonstrate comparatively lower predictive strength. These findings imply that structural and procedural enhancements would yield greater marginal gains in satisfaction than relational improvements alone.

Table 18: Strategic Priority Matrix Based on Effect Size Magnitude

Priority Level	Dimension	Gap Magnitude	Effect Size (d)	Strategic Focus
High Priority	Responsiveness	1.30	1.86	AI-Driven Workflow Optimization
High Priority	Tangibles	1.20	1.71	Infrastructure Modernization
Medium	Reliability	0.90	1.29	Digital Verification Systems
Medium	Empathy	0.77	1.10	Personalization Training
Lower	Assurance	0.65	0.93	Continuous Professional Development

Effect size prioritization clearly identifies Responsiveness and Tangibles as strategic intervention targets (Table 18). Their large-to-very-large practical effects indicate that invest-

ments in workflow automation, AI-supported scheduling and facility modernization are likely to generate the most substantial improvements in satisfaction outcomes. Conversely, Assurance and Empathy, while important, exhibit smaller marginal impact, suggesting that relational enhancements should complement rather than substitute operational reform.

Evaluation of BPJS Employment Branch

Office Facilities Based on FGD Participants' Perceptions

Branch Office Area Analysis and Physical Environment Observations

The word cloud generated from FGD responses indicates that the physical environment plays a decisive role in shaping participant comfort and perceived service quality. Frequently occurring terms such as "room," "waiting room," and "hot" suggest that several branch offices experience spatial constraints, inadequate ventilation and limited climate control. These environmental deficiencies become particularly problematic during peak service hours, amplifying physical discomfort and negatively influencing participants' service evaluations (43).

Participants further emphasized that narrow corridors and densely arranged seating reduce mobility within the office. This spatial limitation not only undermines comfort but also increases potential safety risks, particularly for elderly participants and individuals with disabilities. Rather than functioning merely as operational inconveniences, these environmental shortcomings structurally constrain accessibility and inclusivity, thereby weakening the institution's service equity commitment. Consequently, spatial redesign and ergonomic restructuring are necessary to align office infrastructure with diverse participant needs (43).

Moreover, FGD responses reveal that the physical environment significantly shapes perceptions of organizational professionalism. Cleanliness, lighting adequacy and room organization were repeatedly mentioned as determinants of trust and satisfaction. This suggests that environmental quality functions as a symbolic representation of institutional credibility, reinforcing or undermining perceived service reliability. Investments in ergonomic layout, climate control systems and improved spatial planning would therefore not only enhance comfort but also strengthen participants' confidence in institutional competence (43).

Participant Sentiments Regarding Office Facilities (Queue, Access, Signage)

Queue management emerged as a central issue in participant discussions. Words such as "queue," "number," and "waiting" dominated the word cloud, reflecting dissatisfaction with unclear queuing procedures and inefficient turn-notification mechanisms. Participants reported that uncertainty regarding their queue position amplified perceived waiting times, even when objective delays were moderate (44).

Signage and navigational clarity were also highlighted as systemic weaknesses. First-time visitors, in particular, experienced confusion due to limited directional guidance and poorly labeled service counters. Insufficient information regarding required documentation further contributed to repeated inquiries and slowed service flow (44).

Importantly, these issues are not isolated operational flaws but interconnected elements of participant flow management. Inefficient queuing systems combined with inadequate signage create cumulative friction within the service experience. Digital interventions—such as interactive kiosks, mobile-based queue tracking and improved audio-visual announcements—were suggested during FGDs. When strategically integrated, these tools could reduce cognitive uncertainty, streamline participant movement and significantly enhance perceived efficiency and transparency (44).

Comments on Comfort

Comfort-related concerns were consistently expressed, with recurring words such as "chair," "standing," and "sitting" indicating insufficient seating capacity in waiting areas. Participants described discomfort caused by prolonged standing during peak hours, which adversely affected their overall service experience (45).

High noise levels and crowd density further intensified dissatisfaction. Terms including "noise," "crowd," and "speakers" suggest that excessive ambient noise and limited acoustic control disrupted communication and heightened stress. Participants reported difficulty hearing announcements and engaging effectively with staff, contributing to frustration and perceived inefficiency (45).

These findings suggest that comfort is not merely a peripheral environmental factor but a mediating variable influencing satisfaction and perceived responsiveness. A well-designed, spacious and acoustically controlled waiting area equipped with ergonomic seating can significantly enhance participant well-being and reinforce perceptions of professionalism. Improving environmental comfort therefore represents both a human-centered service initiative and a strategic investment in institutional reputation (45).

Recommendation (Condensed and Synthesized)

Several findings—particularly those related to comfort and responsiveness—are reiterated across sections without sufficient analytical integration. To avoid redundancy and strengthen theoretical contribution, future revisions should condense overlapping observations and emphasize structural linkages between environmental quality, operational responsiveness and satisfaction outcomes. Rather than treating comfort and responsiveness as separate issues, the discussion should synthesize them as interconnected dimensions of service system design, highlighting how infrastructural constraints directly influence perceived efficiency and trust.

Discussion

Identification of Service Gaps

The analysis of the internal Table 1–8 and external surveys Table 9–13 indicates that BPJS Ketenagakerjaan consistently experiences moderate to high gaps between participant expectations and service performance across multiple TERRA dimensions (Tangibles, Reliability, Responsiveness, Assurance, Empathy) and governance-related dimensions (Good Governance, Risk Management, Control) (28, 45).

The Tangibles dimension shows that both internal and external participants perceive physical facilities as partially adequate but highlight concerns such as waiting room comfort, availability of modern facilities, cleanliness and office layout (33, 41). These findings are reinforced by FGD results, where participants repeatedly cited cramped spaces, insufficient seating, high noise and poor ventilation as major discomfort factors (46, 47).

Reliability gaps indicate that timeliness, consistency and accuracy of services remain key areas for improvement (34, 44). Despite general satisfaction, inconsistencies between branches or delays in service delivery undermine trust and satisfaction, suggesting a need for standardized procedures, AI-driven workflow optimization and digital monitoring tools to ensure consistent service quality.

Responsiveness and Staff Competency

The Responsiveness dimension Table 3, 7, 11 indicates that participants expect faster response times and more effective problem-solving, especially in urgent cases (35, 44). Internal survey data shows gaps in staff responsiveness and ability to handle participant inquiries efficiently, while FGD participants highlighted frustrations with queuing systems, unclear instructions and poor communication (47).

Improving responsiveness requires both process acceleration and skill development. AI-assisted task management, digital queue tracking and decision-support systems can enhance operational efficiency while allowing staff to focus on high-value interactions (43, 47). Staff training programs emphasizing communication, empathy and rapid problem-solving are critical for aligning participant expectations with actual service delivery (45).

Assurance, Trust and Information Reliability

Assurance scores Table 4, 8, 12 show moderate gaps in participant trust related to the reliability of information provided and perceived service quality (36,44). FGD findings suggest participants expect staff to provide clear, accurate and reliable information consistently, which influences overall confidence in BPJS Ketenagakerjaan services (48).

Technological interventions can support assurance by standardizing information delivery through digital verification systems, AI-assisted knowledge bases and staff decision-support tools. Continuous professional development ensures staff maintain knowledge and skills aligned with participants' expectations, thereby improving perceived reliability and organizational credibility (44).

Empathy and Participant-centered Service

Empathy gaps Table 5, 10, 13; and FGD, highlight the importance of personalized attention, emotional engagement and participant-centered service (37, 48). Participants appreciate staff who are caring but still expect more personalized

interactions. Word cloud analyses from FGD reveal that participants value attentiveness to emotional and psychological needs, which cannot be fully addressed through standard procedures (46).

Addressing empathy requires both human-centered training and technology-assisted monitoring. AI tools can analyze sentiment from participant interactions and social media feedback to inform staff about service bottlenecks and emotional response patterns, enabling tailored engagement strategies (45, 47).

Governance, Risk Management and Control

The Good Governance, Risk Management and Control dimensions Table 6–8 indicate that gaps exist in transparency, accountability, policy consistency and risk mitigation effectiveness (37, 39). While participants recognize some satisfactory practices, inconsistencies in oversight, policy implementation and risk communication reduce confidence in the organizational system.

Technological solutions such as AI-driven dashboards, predictive risk analytics and automated compliance monitoring can enhance governance by providing real-time oversight, tracking service performance and improving decision-making transparency (39, 41). These interventions can contribute to sustainable service quality by strengthening trust and organizational accountability.

Accountability and control mechanisms identified in this study should be more explicitly anchored within established public-sector governance and sustainability management frameworks. In public administration literature, accountability extends beyond procedural compliance; it encompasses transparency, answerability, enforceability and stakeholder responsiveness. Within this context, control systems function not merely as monitoring tools but as institutional safeguards that ensure policy consistency, risk mitigation and long-term service reliability.

Linking the findings to public-sector governance frameworks—such as principles of good governance (transparency, accountability, participation, rule of law and effectiveness)—clarifies how control dimensions contribute to institutional sustainability. From a sustainability management perspective, accountability mechanisms support institutional resilience by promoting adaptive learning, performance monitoring and responsible resource utilization. Effective control systems reduce operational uncertainty, enhance trust and align organizational practices with long-term economic and social objectives.

Integration of FGD Insights with Survey Data

FGD analyses complement quantitative survey data by providing contextual and qualitative insights. Participants highlighted physical discomfort, queue management issues and poor signage as practical barriers that exacerbate gaps observed in Tangibles, Responsiveness and Empathy (46, 48). This integration demonstrates the value of a mixed-methods approach, where AI and technology can not only improve operational metrics but also address human-centered service concerns.

By combining survey data and FGD insights, BPJS Ketenagakerjaan can prioritize interventions, focusing on digital solutions for workflow optimization, staff training for empathy and responsiveness and physical environment improvements to enhance participant satisfaction and trust (43, 48).

Implications for Sustainable Service Quality

Overall, the results underscore that sustainable service quality requires a holistic approach, integrating technology adoption, staff competency, process optimization and participant-centered strategies. AI can provide predictive analytics, sentiment analysis and workflow automation, while human-centered training ensures services meet emotional, informational and relational needs of participants (41, 47).

Sustainable improvements in service quality not only enhance participant satisfaction but also increase trust, loyalty and organizational credibility, which are crucial for long-term success in public social security systems (28, 48).

Conclusion

The comprehensive evaluation of BPJS Ketenagakerjaan service quality, integrating internal and external surveys (Tables 1–13) and FGD findings, indicates several key insights. First, the TERRA dimensions—Tangibles, Empathy, Responsiveness, Reliability, Assurance, Good Governance, Risk Management and Control—consistently revealed moderate gaps between participant expectations and perceived performance across most elements. Tangibles and

physical facilities, in particular, showed gaps in cleanliness, seating and environmental comfort, suggesting the need for targeted improvements in office infrastructure.

Second, the internal survey demonstrated that while Reliability, Assurance and Control performed relatively well, aspects such as service consistency, timely delivery and standardized oversight still require reinforcementExternal surveys mirrored these results, highlighting additional gaps in Responsiveness, Empathy and Assurance, where participants expected faster service, more personalized attention and more reliable information. These findings indicate that even with adequate procedural frameworks, staff capacity and interaction quality significantly influence participant satisfaction and trust.

Third, the FGD analysis complemented the survey results by providing qualitative insights into participant perceptions of branch office facilities and service flow. Participants emphasized issues with queuing systems, signage, accessibility, crowding and noise levels, all of which affected comfort and perceived service efficiency. The word cloud and sentiment analysis revealed that physical environment and service delivery processes are interrelated determinants of overall participant satisfaction.

Finally, integrating the survey and FGD results suggests that strategic improvements in both digital and physical service infrastructure are essential. Implementing AI-assisted systems for queue management, predictive risk monitoring and participant feedback analysis could optimize service responsiveness and consistency. Likewise, upgrading physical facilities, improving seating, reducing noise and enhancing signage would directly improve participant experience and comfort. Together, these interventions can strengthen participant trust, increase satisfaction and support sustainable service excellence within BPJS Ketenagakerjaan.

Abbreviations

AI: Artificial Intelligence, BPJS Ketenagakerjaan: Badan Penyelenggara Jaminan Sosial Ketenagakerjaan, EMR: Electronic Medical Records, EU: European Union, FGD: Focus Group Discussion, GLSS: Green Lean Six Sigma, ICT: Information and Communication Technology, IoT: Internet of Things, SERVQUAL: Service Quality Model, TAM: Technology Acceptance Model.

Acknowledgement

The authors would like to express their sincere gratitude to Badan Penyelenggara Jaminan Sosial (BPJS) Ketenagakerjaan for the financial support provided for this research.

Author Contributions

Abdur Rahman Irsyadi: conceptualization, study design, Arief Dahyan Supriadi: conceptualization, study design, data curation, methodology, Tarimantan S Saragih: conceptualization, study design, research, Fergie S Mahaganti: conceptualization, study design, formal analysis, resources, An Nisa Pramasanti: Tarimantan S Saragih: conceptualization, study design, research, supervision, Fadly Eka Pradana: Tarimantan S Saragih: conceptualization, study design, research, validation, Rendra H Hutabarat: Tarimantan S Saragih: conceptualization, study design, research, display, Denny Siregar: Tarimantan S Saragih: conceptualization, study design, research, drafting – original draft, R Mochammad Andika Putra: Tarimantan S Saragih: conceptualization, study design, research, writing – proofreading and editing. All authors have read and approved the final version of the manuscript.

Conflict of Interest

The authors declare no conflict of interest related to the publication of this manuscript.

Data Availability

No new data were generated or analyzed in this study. All sources used are publicly available and cited within the manuscript.

Declaration of Generative AI and AI-Assisted Technologies in the Writing Process

No generative AI tools were used in the writing process of this manuscript.

Ethics Approval

This study is based on historical analysis and theoretical review of publicly available sources. Therefore, ethical approval was not required.

Funding

This research was funded by the Badan Penyelenggara Jaminan Sosial (BPJS) Ketenagakerjaan, Republic of Indonesia, Fiscal Year 2025. The authors gratefully acknowledge this financial support, which made the study possible.

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How to Cite: Irsyadi AR, Supriadi AD, Saragih TS, Mahaganti FS, Pramasanti AN, Pradana FE, Hutabarat RH, Siregar D, Putra RMA. Technology For Sustainable Healthcare Quality**.** Int Res J Multidiscip Scope. 2026;7(2):1778-1792. DOI: 10.47857/irjms. 2026.v07i02.010109