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Development of a Geographic Information System Quality Evaluation Framework Using WebQual 4.0 and ISO/IEC 25010 Approaches: A Case Study on Bali Province Balisatudata Website

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Abstract: Geographic Information Systems (GIS) are important tools for managing spatial data in various sectors such as urban planning and environmental management. However, poor GIS quality can hinder accurate decision-making. This study aims to develop an integrated GIS quality evaluation framework by combining two approaches: WebQual 4.0 and ISO 25010. WebQual 4.0 focuses on quality from the user's perspective, while ISO 25010 evaluates the technical characteristics of the software.This research was conducted to evaluate the impact of comparing measurement results using the WebQual 4.0 and ISO 25010 methods on GIS quality, as well as to develop an integrated framework that includes practical recommendations for evaluating GIS quality using the WebQual 4.0 and ISO 25010 methods. Data was collected from 100 active GIS users on the balisatudata.baliprov.go.id website and analyzed using the Importance Performance Analysis (IPA) method. The results showed that the integration of the two methods produced a more comprehensive evaluation of GIS quality compared to a single method. Key findings include quality attributes that need improvement, such as classification accuracy and data position accuracy, as well as system accessibility and reliability. This framework provides an important contribution as a guideline for GIS developers in improving system quality from technical, data, and user satisfaction aspects, as well as a basis for data-driven decision-making.

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INTRODUCTION

This research focuses on measuring the quality of Geographic Information Systems (GIS) using two frameworks, WebQual 4.0 and ISO 25010. GIS is an important technology that integrates software and hardware to collect, analyze, and display spatial data, serving various sectors such as urban planning, environmental management, and logistics (Attah et al., 2024; Patel, 2025). The research objectives include evaluating the effectiveness and user satisfaction of GIS, particularly in terms of how GIS meets user needs and expectations. (Astari & Zuhriyanto, 2025).

Currently, there is an increasing reliance on GIS for decision-making processes in various fields. High-quality GIS data and systems are essential for accurate analysis and sound decision-making (Lasaiba, 2023; Sharma et al., 2024). Poor GIS quality can have a significant impact on decision-making, especially in cases where the data used is inaccurate, incomplete, or never updated, which in turn can lead to errors in policy or strategy determinatio (Sari et al., 2024) n. By evaluating GIS through existing quality frameworks such as WebQual 4.0 and ISO 25010. This is important not only for improving existing systems but also for guiding the future development of GIS technology.

A pressing issue in the field of GIS is the subjective nature of quality assessment. Many existing evaluations lack a standardized approach, leading to inaccuracies in analysis results and inconsistencies in measuring user satisfaction and system performance (Rahman et al., 2021). Additionally, as GIS technology evolves, there is an increase in the complexity of its functions, requiring robust evaluation methods to ensure that GIS can effectively meet user needs (Droj et al., 2024). The integration of various frameworks for quality measurement has not yet been explored, presenting challenges in achieving comprehensive assessments.

Previous research has highlighted various aspects of GIS quality assessment using different models. Research proposing a conceptual framework based on the ISO 25010 model for measuring the quality of GIS applications (Rahman et al., 2021). Similarly, research evaluating GIS system quality using WebQual 4.0 covers usability, information, and interaction. However, there is still a gap in the literature regarding the combined application of these frameworks specifically for GIS, indicating a need for further exploration.

The research gap identified is the lack of an integrated approach combining WebQual 4.0 and ISO 25010 to assess GIS quality. While both frameworks offer valuable insights into different quality dimensions, WebQual focuses on user experience and ISO 25010 addresses software characteristics. By integrating WebQual 4.0 and ISO 25010, this research can create a holistic approach that not only assesses software quality and user experience but also ensures that the geospatial data used meets adequate quality standards. WebQual 4.0 focuses on the user perspective, which includes interaction, interface, perception, and service. Evaluating web service quality with ISO 25010 integration adds to the technical/software engineering perspective, which includes performance, security, reliability, maintainability, and comprehensive system quality evaluation. This approach is expected to provide a more comprehensive view of GIS performance and reliability.

This research was conducted to develop an integrated framework combining WebQual 4.0 and ISO 25010, evaluate GIS implementation, identify current strengths using this integrated framework and areas for improvement, and provide a practical evaluation matrix to enhance the quality and effectiveness of GIS.

RESEARCH METHODS

Research Methodology Flowchart

The first step in the research was to determine the problem formulation and objectives, as shown in the research methodology flowchart in Fig. 1. Next, a literature study was conducted to determine the ideas to be used in the research and to collect data. Information on the WebQual 4.0 and ISO 25010 methods was collected, as well as a combination of the three, to assess the Geographic Information System from the perspective of service users.

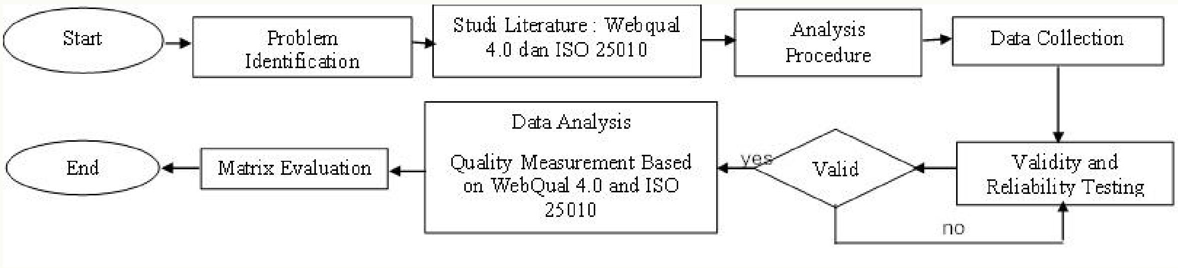

Figure 1. Research Methodology Flowchart

Identify the Problem

In identifying problems, we can find out the problems with the Geographic Information System at https://balisatudata.baliprov.go.id, using various methods that can provide qualitative and quantitative insights. The following are the approaches taken to identify problems on the website:

1. Interviews and Observations

At https://balisatudata.baliprov.go.id, interviews were conducted with several internal parties directly involved in the website's operations, namely the Technical Staff. These interviews aimed to uncover the issues faced by the institution directly, providing a deeper understanding of the challenges faced by the website.

2. Internal Data Collection

In addition to interviews, data was collected using web analytics tools such as Google Analytics. The quantitative data obtained from these tools, such as the number of users, was very helpful in identifying areas that require improvement. This data provides important information regarding the website's performance that can be further optimized.

Analysis Procedure

This study uses the WebQual 4.0 and ISO 25010 mapping methods as a framework for evaluating the quality of geographic information systems. WebQual 4.0 is a measurement designed to assess the quality of a website from the user's perspective, with an emphasis on elements such as utility, information, interaction, and trust (Safitri et al., 2024; Raposo et al., 2025). Meanwhile, ISO 25010 is an international standard for providing criteria for assessing software quality, covering characteristics such as functionality, performance, security, and maintainability (Moumane & Idri, 2023). The purpose of combining these two methods is to enhance understanding of the quality of geographic information systems from the perspective of service users. This research not only measures quality from the software and user experience perspectives but also ensures that spatial data meets the necessary standards to support accurate decision-making. This holistic approach provides a strong foundation for improving the overall quality of geographic information systems.

Integrating the WebQual 4.0 and ISO 25010 methods in the evaluation of geographic information system (GIS) quality can provide a more comprehensive perspective on system quality in terms of user satisfaction and software technical standards (Syuaib & Fauzi, 2023). The following is an explanation of the integration procedure for the two methods:

1. Identification of the Main Dimensions of WebQual 4.0 and ISO 25010

First, WebQual 4.0 measures quality in terms of user experience on websites, divided into three main dimensions: usability, information quality, and service interaction quality. ISO 25010 focuses more on the technical characteristics of software, with six selected dimensions: functional suitability, reliability, performance efficiency, maintainability, compatibility, and interaction capability. The selected dimensions are those that can influence user experience and satisfaction when using the SIG. These dimensions will be integrated with the dimensions of WebQual 4.0 and ISO 25010 to create a more comprehensive evaluation framework.

2. Mapping the Alignment of WebQual 4.0 and ISO 25010 Dimensions

After identification, a mapping of the compatibility between the WebQual 4.0 and ISO 25010 dimensions was conducted to examine the relationships between characteristics. This mapping aims to identify the interconnections between the dimensions and indicators in WebQual 4.0 and ISO 25010 so that a comprehensive questionnaire can be developed that aligns with the aspects to be measured. By combining these two standards, the research can evaluate not only the quality of the user interface and software, but also the quality of the spatial data underlying decision-making in GIS.

3. Development of an Integrated Evaluation Instrument

Based on the mapping above, an evaluation instrument integrating the dimensions of WebQual 4.0 and ISO 25010 will be created in Table I.

Table 1. Integration of Webqual 4.0 and ISO 25010

Dimension	Characteristics
WebQual 4.0	Usability
WebQual 4.0	Information Quality
WebQual 4.0	Service Interaction Quality
ISO/IEC 25010	Functional Suitability
ISO/IEC 25010	Performance Efficiency
ISO/IEC 25010	Compatibility
ISO/IEC 25010	Usability
ISO/IEC 25010	Reliability
ISO/IEC 25010	Security
ISO/IEC 25010	Maintainability
ISO/IEC 25010	Portability

The quality of Geographic Information Systems (GIS) is evaluated using two main frameworks, namely WebQual 4.0 and ISO 25010. These two methods have different focuses but complement each other. As shown in Table I, the attributes of Usability, Information Quality, and Service Interaction Quality are part of the WebQual 4.0 dimensions, while the dimensions defined by ISO 25010 include Functional Suitability, Reliability, Performance Efficiency, Compatibility, Maintainability, and Interaction Capability. All attributes in Table I will be measured for quality based on their alignment with the performance of the Geographic Information System.

RESULTS AND DISCUSSION

Questionnaire Development

The research was conducted using a quantitative approach with the aim of obtaining values or determining the level of satisfaction with the quality of GIS. Based on this research approach, stages were carried out using quantitative methods, tools, and techniques. Data collection was conducted through a survey using a questionnaire instrument. To answer each questionnaire, respondents were required to provide ratings based on a Likert scale ranging from 1 to 5. This scale allowed respondents to indicate their agreement or disagreement with the statements. A score of 1 indicated "Strongly Disagree" and 5 indicated "Strongly Agree." Before answering, respondents must consider the GIS context and provide answers that best reflect their experiences with the quality of the geographic information system being measured. Each question is designed to cover key elements of the relevant dimension. The results obtained now provide an accurate picture of GIS quality based on user perceptions.

1. Development of Webqual instruments

In the preparation of the WebQual questionnaire instrument, the question items were adapted from the Barnes and Vidgen (2002) reference as cited in Anwarudin et al. (2024). The questionnaire format is arranged based on indicators that are in accordance with the WebQual 4.0 method, as described in Table 2.

Table 2. Webqual 4.0 Method Questionnaire List

Sub-dimension	Webqual question	Question Code	Questionnaire	References
Usability	Easy to operate	US1	Is SIG https://balisatudata.baliprov.go.id easy to operate?	(Anwarudin et al. 2024)
	Clear and understandable	US2	Is interaction with SIG https://balisatudata.baliprov.go.id clear and understandable?	(Anwarudin et al., 2024)
	Clear navigation/instructions	US3	Is SIG https://balisatudata.baliprov.go.id easy to navigate?	(Anwarudin et al., 2024)
	Attractive display	US4	Is the appearance of SIG https://balisatudata.baliprov.go.id attractive?	(Anwarudin et al., 2024)
	Display appropriate for the type of website	US5	Does the appearance of SIG https://balisatudata.baliprov.go.id match the type of SIG?	(Anwarudin et al., 2024)
	Changes and knowledge from the	US6	Does using SIG https://balisatudata.baliprov.go.id provide additional knowledge from the information provided?	(Anwarudin et al., 2024)
	website	US7	Is the layout of information on SIG https://balisatudata.baliprov.go.id well-organized?	(Anwarudin et al., 2024)
	Accurate layout of information	US8	Is it easy to find the website address https://balisatudata.baliprov.go.id?	(Anwarudin et al., 2024)
Information Quality	Providing reliable information	IQ1	Does SIG baliprov.go.id provide reliable information?	(Anwarudin et al., 2024)
	Providing up-to-date information	IQ2	Does the SIG https://balisatudata.baliprov.go.id provide up-to-date information?	(Anwarudin et al., 2024)
	Easy-to-understand information	IQ3	Does the SIG https://balisatudata.baliprov.go.id provide information that is easy to read and understand?	(Anwarudin et al., 2024)
	Detailed information	IQ4	Does the SIG https://balisatudata.baliprov.go.id provide sufficient information?	(Anwarudin et al., 2024)
	Relevant information	IQ5	Details?	(Anwarudin et al., 2024)
	Clear information	IQ6	Does the SIG https://balisatudata.baliprov.go.id provide relevant information?	(Anwarudin et al., 2024)

	Presenting information in an appropriate format	IQ7	Does the SIG https://balisatudata.baliprov.go.id provide accurate information?	(Anwarudin et al., 2024)
Service Interaction Quality	Good reputation	SIU1	SIG https://balisatudata.baliprov.go.id Presents information in an appropriate format	(Anwarudin et al., 2024)
	Secure transactions	SIU2	SIG https://balisatudata.baliprov.go.id Has a good reputation	(Anwarudin et al., 2024)
	Securely stored information	SIU3	SIG https://balisatudata.baliprov.go.id Provides security to complete data	(Anwarudin et al., 2024)
	Community atmosphere	SIU4	SIG https://balisatudata.baliprov.go.id Provides a sense of security in submitting personal data	(Anwarudin et al., 2024)
	Ease of attracting interest	SIU5	SIG https://balisatudata.baliprov.go.id Has a community atmosphere	(Anwarudin et al., 2024)
	and attention	SIU6	SIG https://balisatudata.baliprov.go.id makes it easy to attract interest and attention	(Anwarudin et al., 2024)
	Ease of communicati on	SIU7	SIG https://balisatudata.baliprov.go.id makes it easy to communicate (with other agencies/internally)	(Anwarudin et al., 2024)

2. Development of ISO 25010 instruments

In developing the ISO 25010 questionnaire instrument, questions were sourced from existing references. The questionnaire format must be consistent with the indicators based on the ISO 25010 method in Table 3.

Table 3. ISO 25010 Methodology Questionnaire List

Sub-dimension	Webqual question	Question Code	Questionnaire	References
Functional Suitability	SIG features are easy to use and help get the job done.	FS1	SIG https://balisatudata.baliprov.go.id provides functions that suit my task requirements.	(Ratumbuisang et al., 2023)
	SIG responds quickly when I run functions.	FS2	All features SIG https://balisatudata.baliprov.go.id run correctly without errors.	(Ratumbuisang et al., 2023)
	SIG uses resources (CPU, memory) efficiently.	FS3	SIG https://balisatudata.baliprov.go.id features are easy to use and help get the job done.	(Ratumbuisang et al., 2023)
Performance Efficiency	SIG integrates smoothly with	PE1	SIG https://balisatudata.baliprov.go.id responds quickly when I run functions.	(Ratumbuisang et al., 2023)

	other systems (GIS, software).			
	SIG works well in different device environments.	PE2	SIG https://balisatudata.baliprov.go.id uses resources (CPU, memory) efficiently.	(Ratumbuisang et al., 2023)
Compatibility	SIG is easy to learn without lengthy instructions.	C1	SIG https://balisatudata.baliprov.go.id integrates smoothly with other systems (GIS, software).	(Ratumbuisang et al., 2023)
	The user interface is clear and easy to control.	C2	SIG https://balisatudata.baliprov.go.id works well in different device environments.	(Ratumbuisang et al., 2023)
Usability	SIG provides clear feedback when users perform actions.	U1	SIG https://balisatudata.baliprov.go.id is easy to learn without lengthy instructions.	(Ratumbuisang et al., 2023)
	SIG rarely experiences failures or unexpected errors.	U2	The user interface is clear and easy to control.	(Ratumbuisang et al., 2023)
	The system is stable when used over a long period of time.	U3	SIG https://balisatudata.baliprov.go.id provides clear feedback when users perform actions.	(Ratumbuisang et al., 2023)
Reliability	SIG provides protection against unauthorized access and keeps my data secure.	R1	SIG https://balisatudata.baliprov.go.id rarely experiences failures or unexpected errors.	(Ratumbuisang et al., 2023)
	The SIG system handles sensitive data well.	R2	The system is stable when used over an extended period.	(Ratumbuisang et al., 2023)
Security	SIG is easy to update without disrupting existing functions.	S1	SIG https://balisatudata.baliprov.go.id provides protection against unauthorized access, and my data is secure.	(Ratumbuisang et al., 2023)
	The system can be easily modified if improvements are needed.	S2	The SIG https://balisatudata.baliprov.go.id system handles sensitive data effectively.	(Ratumbuisang et al., 2023)
Maintainability	SIG can be run on various	M1	SIG https://balisatudata.baliprov.go.id is easy to update without disrupting	(Ratumbuisang et al., 2023)

	platforms (PC, mobile) without issues.		existing functions.	
	Migrating SIG to other hardware or environments is easy to do.	M2	The system can be easily modified if improvements are needed.	(Ratumbuisang et al., 2023)
Portability	SIG features are easy to use and help get the job done.	P1	SIG https://balisatudata.baliprov.go.id can run on various platforms (PC, mobile) without issues.	(Ratumbuisang et al., 2023)
	SIG responds quickly when I run functions.	P2	Migrating SIG https://balisatudata.baliprov.go.id to other hardware or environments is straightforward.	(Ratumbuisang et al., 2023)

Research Population and Sample

The population in this study consists of active users of SIG https://balisatudata.baliprov.go.id. Using the website similarweb.com, the monthly web population can be determined.

$n = N / 1 + N \cdot e^2$

$n = 79922/1+79922 \times (0,1)^2$

$n = 79922/800,22$

$n \approx 99,87$

If rounded up, the minimum sample size from a population of 79,922 with a margin of error of 10% is 100. The questionnaire was completed by 100 respondents who were academics, consisting of 100 active users of the SIG https://balisatudata.baliprov.go.id/peta-geo-spasial information system. The questionnaire participants in the WebQual 4.0 and ISO 25010 questionnaire method for measuring functional suitability are academic staff consisting of students who are users of the academic information system at IDB Bali and Instinuba. IDB Bali stands for Institut Desain dan Bisnis Bali. IDB Bali is a private university (PTS) in Denpasar, Bali, offering design and business programs. Instinuba stands for Institut NU Bali, a private university (PTS) in Denpasar, Bali, offering information systems programs as active users of the SIG baliprov.go.id system.

Calculation of Validity and Reliability

Validity testing was conducted using Pearson's statistical test with a critical correlation coefficient obtained from the r distribution table using a significance level of 5%, so that the r-table with 100 respondents = 0.195. If the calculated r-value is greater than the r-table value, the variable is declared valid.

1. Calculation of validity and reliability of the Webqual 4.0 Questionnaire

The results of the validity testing of the Webqual 4.0 questionnaire for the variables studied are presented in Table 4.

Table 4. Webqual 4.0 Validity Calculation Table

No	Question Code	R-Calculated	r- Table	Description	Description
1	US1	0.448	0.195	r positif, r hitung>r Tabel	Valid
2	US2	0.339	0.195	r positif, r hitung>r Tabel	Valid
3	US3	0.520	0.195	r positif, r hitung>r Tabel	Valid
4	US4	0.456	0.195	r positif, r hitung>r Tabel	Valid
5	US5	0.350	0.195	r positif, r hitung>r Tabel	Valid

6	US6	0.379	0.195	r positif, r hitung>r Tabel	Valid
7	US7	0.547	0.195	r positif, r hitung>r Tabel	Valid
8	US8	0.436	0.195	r positif, r hitung>r Tabel	Valid
9	IQ1	0.454	0.195	r positif, r hitung>r Tabel	Valid
10	IQ2	0.578	0.195	r positif, r hitung>r Tabel	Valid
11	IQ3	0.604	0.195	r positif, r hitung>r Tabel	Valid
12	IQ4	0.454	0.195	r positif, r hitung>r Tabel	Valid
13	IQ5	0.578	0.195	r positif, r hitung>r Tabel	Valid
14	IQ6	0.604	0.195	r positif, r hitung>r Tabel	Valid
15	IQ7	0.547	0.195	r positif, r hitung>r Tabel	Valid
16	SIU1	0.436	0.195	r positif, r hitung>r Tabel	Valid
17	SIU2	0.454	0.195	r positif, r hitung>r Tabel	Valid
18	SIU3	0.547	0.195	r positif, r hitung>r Tabel	Valid
19	SIU4	0.053	0.195	r positif, r hitung>r Tabel	Invalid
20	SIU5	0.121	0.195	r positif, r hitung>r Tabel	Invalid
21	SIU6	0.031	0.195	r positif, r hitung>r Tabel	Invalid
22	SIU7	0.454	0.195	r positif, r hitung>r Tabel	Valid

Table 4 shows the total 22 statement items in the WebQual 4.0 instrument, 19 items (86.36%) were declared valid because they had an r-count value greater than the r-table (0.195) and were positive. Meanwhile, there are 3 invalid items, namely SIU4, SIU5, and SIU6, because the r-count value is smaller than the r-table. Thus, the instrument as a whole has a high level of validity and can be used in evaluating the quality of GIS, although improvements or replacements need to be made to the invalid items.

Table 5. Results of Webqual Questionnaire Reliability Calculations

Cronbach alpha	Number of questions
0.772	22

According to Sugiyono, 2013, the minimum score is 0.6, therefore the reliability of Webqual is valid. The results of the Cronbach alpha reliability test in Table V show a reliability score of 0.772, therefore the 22 statements in the instrument can be declared valid.

2. Calculation of the validity and reliability of the ISO 25010 questionnaire

The results of the validity test of the ISO 25010 questionnaire for the variables studied are presented in Table 6.

Table 6. ISO 25010 Validity Calculation Table

Number	Question Code	R-Calculated	R- Table	Description	Description
1	FS1	0.799	0.195	r positif, r hitung>r Tabel	Valid
2	FS2	0.545	0.195	r positif, r hitung>r Tabel	Valid
3	FS3	0.799	0.195	r positif, r hitung>r Tabel	Valid
4	PE1	0.728	0.195	r positif, r hitung>r Tabel	Valid

5	PE2	0.601	0.195	r positif, r hitung>r Tabel	Valid
6	C1	0.615	0.195	r positif, r hitung>r Tabel	Valid
7	C2	0.576	0.195	r positif, r hitung>r Tabel	Valid
8	U1	0.397	0.195	r positif, r hitung>r Tabel	Valid
9	U2	0.799	0.195	r positif, r hitung>r Tabel	Valid
10	U3	0.545	0.195	r positif, r hitung>r Tabel	Valid
11	R1	0.799	0.195	r positif, r hitung>r Tabel	Valid
12	R2	0.728	0.195	r positif, r hitung>r Tabel	Valid
13	S1	0.601	0.195	r positif, r hitung>r Tabel	Valid
14	S2	0.615	0.195	r positif, r hitung>r Tabel	Valid
15	M1	0.576	0.195	r positif, r hitung>r Tabel	Valid
16	M2	0.397	0.195	r positif, r hitung>r Tabel	Valid
17	P1	0.099	0.195	r positif, r hitung>r Tabel	Invalid
18	P2	0.369	0.195	r positif, r hitung>r Tabel	Valid

Table 6 shows that the validity of the ISO 25010 questionnaire in this study, with a calculated r greater than the table r of 0.195, means that all 14 items can be declared valid.

Table 7. Results Of Iso 25010 Questionnaire Reliability Calculations

Cronbach alpha	Number of questions
0,881	18

According to Sugiyono, the minimum score is 0.6, therefore the reliability of ISO 25010 is declared valid. The results of the Cronbach alpha reliability test in Table 7 show a reliability score of 0.881, therefore the 18 statements in the instrument can be declared valid.

Comparison of satisfaction levels and gaps using WebQual 4.0 and ISO 25010 methods

1. Percentage of satisfaction and gap using the Webqual method

Table VIII shows the percentage of satisfaction with the application. In this session, we'll calculate the gap between expectations/importance and reality/performance.

Table 8. Satisfaction Level and Gap Results Using the Webqual Method

Dimension	Total score			
	Performance (Xi)	Expectations (Yi)	Respondent conformity (TKI)	(Gap)
Usability	3.51	3.97	88.36	-0.46
Information Quality	3.57	4.00	89.30	-0.43
Service Interaction Quality	3.39	4.00	84.75	-0.61
	3.49	3.99	87.47	-0.50

Performance scores (actual) are derived from the average scores of the Webqual sub-dimension expectation questionnaire. Expectations are the average scores on the Webqual expectation questionnaire. Satisfaction levels are derived from the ratio of actual to expected questionnaire scores multiplied by one hundred percent. The gap is the difference between expectations and reality. Based on Table VIII, the level of user satisfaction using the Webqual method is 88.36%, and the average gap difference is 0.22. In this dimension, the highest level of satisfaction is in the overall dimension, and the largest gap is in the information quality dimension.

2. Percentage of satisfaction level and gap using the ISO 25010 method

Table IX outlines the percentage of satisfaction with the application. In this session, the gap between expectations/importance and reality/performance will be calculated.

Table 9. Satisfaction Level and Gap Results Using the Iso 25010 Method

Dimension	Total score			
	Performance (Xi)	Expectations (Yi)	Respondent (TKI)	conformity (Gap)
Functional Suitability	3.83	4.35	87.90	-0.53
Performance Efficiency	3.70	4.31	88.17	-0.51
Compatibility	3.80	4.24	88.29	-0.50
Usability	3.74	4.24	87.31	-0.54
Reliability	3.71	4.16	88.34	-0.49
Security	3.68	4.24	88.90	-0.47
Maintainability	3.77	4.24	90.55	-0.40
Portability	3.66	4.24	89.85	-0.43
	3.73	4.25	88.66	-0.48

Performance values (actual) are derived from the average values of the ISO 25010 sub-dimension expectation questionnaires. Expectations are the average values on the ISO 25010 expectation questionnaires. Satisfaction levels are derived from the ratio of actual to expected questionnaire values multiplied by one hundred percent. The gap is the difference between expectations and reality. Based on Table IX, the level of user satisfaction using the ISO 25010 method is 94.82%, and the average gap difference is 0.40. In this dimension, the highest level of satisfaction is in the Security Usability dimension, and the largest gap is in the Compatibility dimension.

Weight-Based Measurement Using AHP

The results of the study conducted using the WebQual 4.0 method are presented in Table 10.

Table 10. Measurement Table Based on AHP Weighting in Webqual

Sub karakteristik	**Weight (*Wi*)**	**Performance Value (*Ri*)**	**∑(*Ri*×*Wi*)**
Usability	0.429	3.51	1.51
Information Quality	0.429	3.57	1.53
Service Interaction Quality	0.142	3.39	0.48
		amount	3.52

Next, it was compared with the combined WebQual 4.0 and ISO 25010 methods.

Table 11. Measurement Table Based on AHP Weighting in Webqual

	Weight (W)	**Nilai Kinerja (*Ri*)**	**∑(*Ri*×*Wi*)**
Usability	0.429	3.66	1.57
Information Quality	0.429	3.63	1.56
Service Interaction	0.142	3.56	0.51
		jumlah	3.63

Table 12. Measurement Table Based on AHP Weighting in ISO 25010

	Weight (W)	Performance Value (*Ri*)	∑(*Ri*×*Wi*)
Functional Stability	0.22	3.83	0.84
Performance Efficiency	0.15	3.70	0.56
Compatibility	0.18	3.80	0.68
Usability	0.09	3.74	0.34
Reliability	0.15	3.71	0.56
Security	0.1	3.68	0.37
Maintainability	0.18	3.77	0.68
Portability	0.1	3.66	0.37
		amount	4.39

Data Analysis using T-Test

After collecting and calculating the data, the next step is to calculate the level of user satisfaction by comparing the expected and actual figures.

Table 13. Measurement Data Analysis Using T-Test

Dimension	WebQual 4.0	WebQual 4.0 and ISO 25010	Gap
Usability	3.51	3.7	0.15
Information Quality	3.57	3.63	0.06
Service Interaction Quality	3.39	3.56	0.17
Functional Suitability	-	3.83	3.83
Performance Efficiency	-	3.70	3.70
Compatibility	-	3.80	3.80
Reliability	-	3.71	3.71
Security	-	3.68	3.68
Maintainability	-	3.77	3.77
Portability	-	3.66	3.66
Average	**3.49**	**3.70**	**0.21**

Calculation using the IPA Method

After collecting data and performing calculations, the next step is to calculate the level of user satisfaction by comparing the expected and actual figures.

1. Conformity Test

After collecting questionnaire data, the IPA Matrix can be calculated. The steps for calculating IPA are explained in the figure. Based on the test results table, it was found that <0.01 there was no difference between expectations and consumer satisfaction. The questionnaire results were summarized and then the total score for each performance and importance assessment was calculated. Then, the level of conformity was measured. The results of the conformity level measurement (Tki) are shown in Table 14.

Table 14. Measuring the Level of Conformity

ID	(Xi)	(Yi)	(Tki)	Gap
US1	3.67	4.06	90.39	-0.39
US2	3.70	3.99	92.73	-0.29

US3	3.50	3.78	92.59	-0.28
US4	3.45	3.81	90.55	-0.36
US5	3.65	3.95	92.41	-0.30
US6	3.68	4.06	90.64	-0.38
US7	3.78	4.24	89.15	-0.46
US8	3.87	4.27	90.63	-0.40
IQ1	3.63	4.13	87.89	-0.50
IQ2	3.39	3.91	86.70	-0.52
IQ3	3.51	3.98	88.19	-0.47
IQ4	3.52	3.95	89.11	-0.43
IQ5	3.70	4.04	91.58	-0.34
IQ6	3.77	4.02	93.78	-0.25
IQ7	3.89	4.19	92.84	-0.30
SIU1	3.66	4.14	88.41	-0.48
SIU2	3.38	4.02	84.08	-0.64
SIU3	3.46	3.88	89.18	-0.42
SIU7	3.72	4.03	92.31	-0.31
FS1	3.78	4.34	87.10	-0.56
FS2	3.87	4.36	88.76	-0.49
FS3	3.83	4.36	87.84	-0.53
PE1	3.66	4.30	85.12	-0.64
PE2	3.74	4.32	86.57	-0.58
C1	3.74	4.24	88.21	-0.50
C2	3.86	4.24	91.04	-0.38
U1	3.86	4.28	90.19	-0.42
U2	3.58	4.16	86.06	-0.58
U3	3.79	4.29	88.34	-0.50
R1	3.73	4.16	89.66	-0.43
R2	3.68	4.16	88.46	-0.48
S1	3.72	4.22	88.15	-0.50
S2	3.63	4.25	85.41	-0.62
M1	3.78	4.22	89.57	-0.44
M2	3.75	4.25	88.24	-0.50
P1	3.61	4.22	85.55	-0.61
P2	3.70	4.25	87.06	-0.55

Performance scores (actual) are derived from the average scores of the expectation sub-dimension questionnaires in WebQual 4.0 and ISO 25010. Expectations are the average scores on the WebQual 4.0 and ISO 25010 expectation questionnaires. Satisfaction levels are derived from the ratio of actual to expected questionnaire scores multiplied by one hundred percent [19]. The weighted t-test is a statistical method used when observations in a sample have different levels of importance or variability, and weights are assigned to reflect this. The following are weighted t-tests for each method.

Calculate the Weighted Mean WebQual 4.0

Xw = (1.51 + 1.53 + 0.48) / 1 = 3.5

Calculate the Weighted Mean WebQual 4.0 and ISO 25010

Xw = ((1.57 + 1.56 + 0.51) /0.5) + ((0.84 + 0.56 + 0.68 + 0.34 + 0.56 + 0.37 + 0.68 + 0.37)/0.5) = 4.01

The weight reflects the importance of the observation (e.g., data reliability or subgroup size). On a scale of 1 to 5, the WebQual 4.0 and ISO 25010 methods produce a Weighted Variance value of 4.01, which is higher than the value obtained using the WebQual method = 3.52.

2. IPA Matrix

The results of the attributes that influence respondent/user satisfaction will be analyzed and divided into four quadrants of the Importance Performance Matrix. The Importance Performance Matrix is based on the table of average performance scores and importance scores. After collecting questionnaire data, the IPA Matrix can be calculated. The steps for calculating the IPA are explained in Section III. Questionnaire Results.

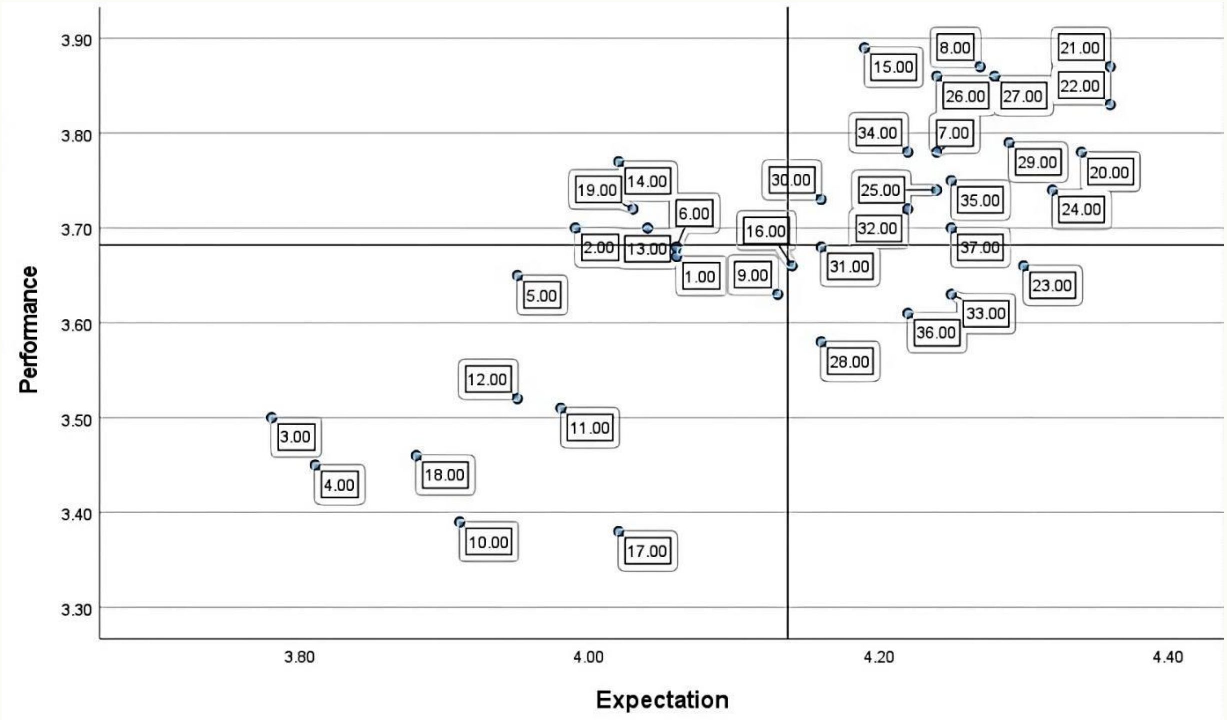

Figure 1. Matrix IPA

The IPA Matrix Diagram has four quadrants, namely quadrant one to quadrant four. Quadrant one means low performance and needs to be improved. Quadrant two means that the application performance is good and should be maintained. Quadrant three means low performance and respondents consider the performance to be low. Quadrant four means good performance but respondents consider it unnecessary. Question attributes can be grouped into each quadrant. Based on Fig. 2, there are several attributes scattered across the IPA quadrants. The following are the results of the analysis using IPA:

a. Quadrant 1 (Focus here)

Quadrant I contains low performance attributes, but users consider the attributes in this quadrant to be important. The attributes in this quadrant are the main weaknesses. Therefore, developers are required to improve their performance in order to achieve higher user satisfaction levels. The following are the attributes in Quadrant I.

US2 Is the interaction with SIG baliprov.go.id clear and understandable?
IQ5 SIG baliprov.go.id provides relevant information.
IQ6 SIG baliprov.go.id provides accurate information.
SIU7 SIG provides a high level of confidence in data delivery.

b. Quadrant 2 (Good Performance)

Quadrant II contains high-performance attributes, and users consider the attributes in this quadrant to be important. Quadrant II attributes include key strengths, and their performance must be maintained to sustain competitive advantage. The attributes in Quadrant II are:

US7 Is the layout of information on SIG baliprov.go.id appropriate?
US8 Ease of finding the website address (balisatudata.baliprov.go.id/peta-geo-spasial)

IQ7 SIG baliprov.go.id Presents information in an appropriate format
SIU1 SIG baliprov.go.id Has a good reputation
FS1 SIG provides functions that align with my task requirements.
FS2 All features work correctly without errors.
FS3 GIS features are easy to use and help complete tasks.
PE2 GIS uses resources (CPU, memory) efficiently.
C1 GIS can integrate smoothly with other systems (GIS, software).
C2 GIS works well in different device environments.
U1 SIG is easy to learn without lengthy instructions.
U3 SIG provides clear feedback when users perform actions.
R1 SIG rarely experiences failures or unexpected errors.
S1 SIG provides protection against unauthorized access and keeps my data secure.
M1 SIG is easy to update without disrupting existing functions.
M2 The system can be easily modified if improvements are needed.
P2 Migrating SIG to other hardware or environments is easy to do.

c. Quadrant 3 (Low Priority)

Quadrant III contains low-performance attributes, and students rate the attributes in this quadrant as unimportant. Therefore, the attributes in Quadrant III are not prioritized for performance improvement. The following are the attributes included in Quadrant III. The attributes in the third quadrant are:

US1 Is SIG baliprov.go.id easy to operate?
US3 Is the SIG baliprov.go.id menu (navigation) easy to find?
US4 Is the SIG baliprov.go.id interface attractive/appealing?
US5 Does the SIG baliprov.go.id interface align with the type of SIG?
US6Does using the SIG baliprov.go.id provide additional knowledge from the information provided?
IQ1 Does SIG baliprov.go.id provide reliable information?
IQ2 Does SIG baliprov.go.id provide up-to-date information?
IQ3 Does SIG baliprov.go.id provide information that is easy to read and understand?
IQ4 Does SIG baliprov.go.id provide sufficiently detailed information?
SIU2 SIG baliprov.go.id provides security for data completion
SIU3 SIG baliprov.go.id provides a sense of security when sharing personal data

d. Quadrant 4 (High Performance but Excessive)

Quadrant IV contains high-performance attributes, but respondents rate the attributes in this quadrant as unimportant. Attributes in Quadrant IV:

PE1 SIG responds quickly when I perform functions.
U2 The user interface is clear and easy to control.
R2 The system remains stable when used for extended periods.
S2 The SIG system handles sensitive data effectively.
P1 SIG can be run on various platforms (PC, mobile) without issues.

3. Recommendations for Application Improvement

Based on the above description, the satisfaction level analysis using a combination of WebQual 4.0 and ISO 25010 methods provides recommendations in Table 12

Table 15. Table of Recommendations for Application Improvement

No.	WebQual 4.0	WebQual 4.0 and ISO 25010
Recommendations for Improvement	Through the WebQual 4.0 method, developers do not have low-performance attributes and are advised to maintain clear and understandable interactions with	Through the WebQual 4.0 and ISO 25010 method, developers are required to improve their performance in interactions with users so that they are clear

	GIS. The GIS display is in accordance with the type of GIS, and GIS provides accurate information.	and easy to understand, provide relevant information, provide accurate information, and SIG provides a high level of confidence in data delivery. Meanwhile, the main advantages of SIG include fast response times when executing functions, a clear and easy-to-control user interface, system stability during prolonged use, effective handling of sensitive data, and the ability to run on various platforms (PC, mobile) without issues.

CONCLUSIONS

The results showed that evaluating the quality of Geographic Information Systems (GIS) using the WebQual 4.0 framework and the combination of WebQual 4.0 with ISO/IEC 25010 both resulted in average scores at a good level, namely 3.49 and 3.7 respectively. Although the difference in scores is only 0.2 and does not show a statistically significant difference, the integration of the two approaches provides a more comprehensive picture in assessing system quality, both in terms of user experience and technical aspects of the software. The implication of this finding is that the integrated approach between WebQual 4.0 and ISO/IEC 25010 is feasible to use as a framework for evaluating the quality of GIS because it is able to cover a wider range of dimensions and support continuous and comprehensive system improvement. Furthermore, this study has several limitations, including the scope of respondents being limited to one local government GIS site, so the results cannot be widely generalized. In addition, the analysis was descriptive and did not use inferential statistical tests to measure the significance of differences between the two evaluation approaches. The evaluation also did not include the perspective of the system developer, whereas technical insights from the developer can provide a deeper understanding of the ISO/IEC 25010 dimensions. Therefore, future research is recommended to expand the scope of respondents by involving users from various GIS platforms, both government and private, in order to obtain more representative results. In addition, the use of inferential statistical methods needs to be done to determine the significance of differences between evaluation methods. The development of evaluation instruments should also combine quantitative and qualitative approaches, such as interviews or FGDs with system developers, in order to enrich the understanding of technical challenges and adapt ISO/IEC 25010 indicators to the needs of web-based GIS evaluation.

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