

Development of an ICT Infrastructure–Based Public Service Transparency Index for Public Accountability in Smart City Local Governments

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Abstract

The development of Smart City initiatives has intensified the use of information and communication technology (ICT) to enhance transparency in local government public services. Official local government websites serve as key digital platforms for delivering information and supporting public accountability. However, existing e-government evaluation frameworks primarily emphasize macro-level indicators, providing limited assessment of transparency at the public service level. This study develops and applies an ICT Infrastructure–Based Public Service Transparency Index to evaluate transparency practices across the official websites of 16 Indonesian Smart City local governments. Using quantitative content analysis of observable website features, the study measures transparency through six dimensions and twelve indicators. The findings indicate relatively limited variation in overall transparency performance across local governments, although notable differences exist across transparency dimensions. Information-oriented dimensions generally achieved higher scores than operational service accessibility dimensions. These findings suggest that transparency practices remain largely document-oriented and highlight the need to strengthen operational service accessibility. The proposed index provides a practical and replicable benchmarking framework for evaluating and improving website-based public service transparency in Smart City implementation.

Keywords:

Smart City; Public Accountability; ICT Infrastructure; Public Service Transparency; Smart Governance

1. Introduction

The development of the Smart City concept has driven a significant transformation in local governance through the use of Information and Communication Technology (ICT) to improve the quality of public services, administrative efficiency, and citizen engagement. A core dimension of Smart City development is smart governance, which emphasizes transparency, accountability, and information openness as fundamental principles of public administration. In this context, local government official websites serve as the main digital platform for disseminating public information and delivering public services to citizens. Previous studies have

highlighted the strategic role of government websites in supporting service provision, communication, and citizen participation (Zhao et al., 2023).

However, empirical evidence consistently reveals substantial gaps in the quality and functionality of local government websites, indicating that ICT adoption does not automatically produce transparent and citizen-oriented governance. Public service transparency remains an important yet underexamined component of smart governance at the local government level. Ideally, official websites should provide clear, comprehensive, and easily accessible information regarding types of services, requirements, and procedures. In practice, however, the level of transparency implementation varies considerably across local governments.

Most existing e-government evaluation frameworks, such as the United Nations E-Government Development Index and Indonesia's Electronic-Based Government System (SPBE), employ complex and multidimensional assessment approaches. Although comprehensive, these frameworks are often insufficiently operational for evaluating public service transparency as directly experienced by citizens through local government websites. To address this limitation, recent studies emphasize that ICT infrastructure serves not only as a technical foundation but also as a support for transparency through observable website features. (OECD, 2023). From this perspective, transparency is conceptualized as a functional outcome reflected in the availability and accessibility of service-related information on government websites.

This limitation is important to examine from a public sector accounting perspective. The availability and accessibility of service information on local government websites is not merely an indicator of technological maturity, but also functions as a public accountability mechanism that enables citizens, auditors, and oversight bodies to verify service delivery performance and the use of public resources (Cucciniello et al., 2020). In this sense, budget and fiscal information disclosure on local government websites can be viewed as an extension of fiscal reporting and accountability practices, while the availability of service channels, complaint mechanisms, and open data reflects a dimension of operational accountability that has so far received little attention in digital transparency studies (Worthy & Waugh, 2024). Thus, website-based transparency is relevant not only to studies of smart governance, but also to research on fiscal accountability and public sector auditability. Information that is openly available on websites, such as budget documents, complaint channels, and service data, can serve as verifiable evidence for auditors, oversight bodies, and citizens alike, because its existence can be checked directly through the website without having to rely on local government internal reports. In other words, the availability of directly observable information on the website is a prerequisite for effective public oversight of local government performance.

Based on these considerations, this study aims to develop and apply an ICT Infrastructure-Based Public Service Transparency Index as a simple and operational benchmarking tool to assess transparency practices on local government websites within the context of Smart Cities in Indonesia. By focusing on observable website features, this study provides an empirically grounded and replicable assessment of public service transparency at the local government level.

2. Literature Review and Theoretical Expectations

Smart Cities and Smart Governance

The concept of the Smart City emerged as a response to the increasing complexity of urban areas and the growing demand for efficient, transparent, and citizen-oriented public services. A Smart City is generally understood as an approach that leverages information and communication technology (ICT) to improve quality of life, optimize resource management, and enhance governance processes. Importantly, Smart City development does not focus solely on technological advancement, but emphasizes the interaction among technology, institutions, and human capital (*Kummita & Crutzen, 2017*).

Recent studies further show that the successful implementation of Smart Cities depends not only on technological infrastructure but also on institutional capacity, governance quality, and citizen engagement. In this regard, ICT functions as an enabler that facilitates transparency, accountability, and collaborative decision-making, rather than as an end goal in itself (*Nurlinah et al., 2025; OECD, 2023*). Consequently, effective smart governance requires local governments to integrate technological innovation with organizational readiness and citizen-oriented service delivery.

Within this framework, smart governance is a central dimension of Smart City development. Smart governance emphasizes transparency, accountability, public participation, and effective public service delivery through digital platforms. Government websites, in particular, serve as the primary ICT infrastructure mediating interactions between local governments and citizens.

E-Government and Public Service Transparency

E-government refers to the use of digital technology by public institutions to deliver information and services and to engage citizens in the governance process. Transparency is widely recognized as a core principle of good governance and is increasingly operationalized through official government websites. Website-based transparency encompasses the availability of service information, the clarity of procedures and requirements, the accessibility of service channels, and the existence of feedback and complaint mechanisms.

Previous studies argue that government websites are among the most representative instruments for evaluating transparency in e-government implementation, as they provide observable and user-oriented indicators of transparency practices (*Criado et al., 2018*). Through website features, transparency becomes a functional outcome rather than merely a normative commitment.

Government Websites as Instruments of Smart Governance

Local government websites function as an integrated digital portal that provides access to public information and services for diverse groups of users. Evaluations of government websites typically assess dimensions such as content quality, accessibility, usability, interactivity, and service support. Websites that offer structured information and clear service guidance tend to demonstrate higher levels of transparency and governance maturity.

Recent empirical evidence shows that government websites designed with greater transparency and interactive features encourage higher levels of citizen participation and improve public perceptions of accountability (*Zhao et al., 2023*).

Conversely, poorly designed websites undermine latent transparency signals and weaken public trust, even when formal information is technically available (*Grimmelikhuijsen et al.,*

2020). This indicates that transparency is determined not only by information disclosure, but also by how effectively information and services are presented and accessed by users.

E-Government Evaluation Models

Various models have been developed to assess the performance and maturity of e-government. Stage-based models conceptualize e-government development as a linear progression from basic information provision to integrated and participatory services. However, these models have been criticized for oversimplifying real-world implementation and failing to capture parallel development pathways.

An alternative approach proposed by (Fietkiewicz et al., 2017) conceptualizes e-government as a set of pillars that can develop simultaneously, including information provision, communication, transaction, integration, and participation. This approach is considered more flexible and well suited to evaluating government websites in the context of Smart Cities, as it emphasizes observable website features rather than institutional claims.

Recent studies further argue that transparency evaluation should focus not only on the availability of information but also on the quality of open data, website usability, and user accessibility. These aspects are increasingly recognized as important components of digital transparency because they determine how effectively citizens can access and utilize public information (Lnenicka & Nikiforova, 2021).

Although there is extensive literature on Smart City development, e-government, and digital transparency, many studies rely on complex evaluation frameworks that are difficult to operationalize at the local government level. In addition, limited research has focused on simple website-based benchmarking tools that assess public service transparency through observable, ICT-supported features. This study addresses this gap by proposing an ICT Infrastructure-Based Public Service Transparency Index that evaluates transparency as experienced by users through local government websites.

Theoretical Expectations

Based on the e-government and public sector transparency literature, the development of digital public service transparency is generally expected to vary across different transparency dimensions. Previous empirical studies show that transparency dimensions closely related to formal compliance requirements and standardized information disclosure—such as digital public services, complaint-handling mechanisms, and budget transparency—tend to show higher levels of implementation on official government websites. These dimensions are typically supported by formal regulations, reporting obligations, and centralized administrative procedures, which facilitate more consistent adoption across local governments.

In contrast, transparency dimensions that require a higher degree of operational coordination, inter-organizational data integration, and continuous data updates—such as contact information and service accessibility as well as open data provision—are often reported to be more difficult to implement. The provision of detailed service hours, responsible organizational units, and structured open data portals often depends on sustained institutional capacity and cross-departmental coordination, which previous studies have identified as persistent constraints in local government digital governance.

Regarding regional classification, the literature provides no conclusive evidence that metropolitan and non-metropolitan cities differ systematically in their overall level of digital public service transparency. Although metropolitan cities are often assumed to have greater

administrative capacity and more advanced ICT infrastructure, empirical research shows that these structural advantages do not consistently translate into higher levels of website-based transparency. Non-metropolitan cities, in some cases, show comparable transparency outcomes through more focused digital service delivery strategies, thereby limiting the expectation of statistically significant differences in aggregate transparency index scores between the two groups.

Finally, methodological research on transparency measurement highlights the potential sensitivity of transparency rankings to index construction choices, particularly regarding the aggregation of individual indicators into broader dimensions. The literature indicates that local governments that consistently perform well across various indicators are more likely to maintain stable ranking positions across alternative aggregation approaches, whereas local governments with more uneven indicator performance may show greater ranking variability when the aggregation method is modified.

3. Research Methodology

This study employs a quantitative research design using content analysis to examine public service transparency implemented through official local government websites. Content analysis is widely used in e-government and public administration research to systematically assess website features and online information disclosure practices (Fietkiewicz et al., 2017; Grimmeliikhuijsen et al., 2020). This approach enables transparency to be evaluated based on observable and verifiable website characteristics rather than institutional self-reporting.

The study adopts an ICT infrastructure perspective, where transparency is treated as a functional outcome of digital platforms that facilitate access to public service information in the Smart City context. The unit of analysis in this study is the official website or public service portal of each local government included in the sample. The research objects of this study are the official websites of 16 local governments in Indonesia that have formally adopted Smart City initiatives. These local governments were selected based on official Smart City program designations issued by the central government, reflecting their commitment to digital governance development (Kummitha & Crutzen, 2017).

The primary data source consists of publicly accessible information available on each official local government website and associated public service portals. In several cases, public service functions are delivered through service portals that are separate from the main government website. Therefore, multiple websites were analyzed for a single local government when public services were not integrated into a single platform. Website observations were conducted during the period 27 December 2025 to 30 December 2025. The objects of observation include official local government websites and dedicated public service portals that provide digital public services.

The selection criteria for websites included in this study were as follows:

1. The local government is formally associated with a Smart City program.
2. The official website or public service portal is publicly accessible without authentication.
3. The website contains a public service section or an equivalent digital service portal.

Only website content that could be directly accessed by the public during the observation period was included in the analysis.

Public service transparency is measured using an ICT Infrastructure–Based Public Service Transparency Index developed in this study. The index construction is informed by website-based transparency assessment approaches in prior studies (Fietkiewicz et al., 2017; Criado et al., 2018).

Transparency is operationalized through 12 observable indicators grouped into six dimensions:

1. Digital public services,
2. Complaints & participation,
3. Service contact and access,
4. Budget transparency,
5. Public information updates, and
6. Open data availability.

Table 1. Dimensions and Indicators of the ICT Infrastructure–Based Public Service Transparency Index

Dimensions	Indicator
Digital Public Services	Active online public services
	Digital service forms
Complaints & Participation	Official complaint channels
	Complaint flow/follow-up
Service Contact & Access	Clear service contact details
	Service hours & units
Budget Transparency	Public budget information
	Downloadable budget documents
Public Information & Updates	Updated budget
	Latest news updates
	Substantive program/policy information
Open Data	Open data portal available

A total of 12 indicators were used to measure public service transparency. Each indicator was operationally defined to minimize ambiguity and ensure consistent assessment across websites. All indicators were coded using a binary scoring scheme, where a score of 1 indicates the presence of the feature and a score of 0 indicates its absence.

Equal weighting was applied to all indicators because each represents a minimum and essential transparency feature expected to be available on local government public service websites. Since the objective of this study is to assess the presence of essential transparency practices rather than to prioritize the relative importance of individual indicators, assigning equal weights avoids introducing subjective judgments into the index construction process. Moreover, no established theoretical or empirical evidence was identified to justify differential weighting among the selected indicators. Therefore, equal weighting was adopted to enhance

methodological transparency, maintain the simplicity of the proposed index, and facilitate its replicability in future studies.

Table 2. Operational Definitions and Scoring Criteria of Transparency Indicators

Dimensions	Indicator	Score	
		0	1
Digital Public Services	Online public services are active	Services are only mentioned narratively or in banners without access.	There is a public service menu/page that can be accessed (not a banner/text).
	Digital service form	Only PDF/Word files to download.	Forms can be filled out and submitted online.
Complaints & Participation	Official complaint channel	Just a general email/suggestion box with no system.	The official link (LAPORI/regional complaints) is available and can be accessed.
	Complaint flow/follow-up	The channel exists, but without any explanation of the process.	There are SOPs/flows/stages + time estimates or response mechanisms.
Contact & Service Access	Clear service contact	Contact unclear, dead	Official numbers/emails/WhatsApp are available and can be contacted.
	Service hours & units	Just office address without hours/units.	Information on service hours and related units/OPDs is available.
Budget Transparency	Public budget information	Not available or narrative only.	APBD/budget summary is available and can be accessed by the public.
	Budget documents can be downloaded	Just infographics/images.	Budget documents (PDF/Excel) can be downloaded.
	Updated budget	Older than that or without year information.	Current fiscal year or previous year.
Public Information & Updates	Latest news updates	No updates or just old archives.	There is news/announcement $\leq$ last 3 months.
	Substantive program/policy information	Only news of the ceremony/speech.	The program/policy is explained substantially (objectives/activities).
Open Data	Open data portal available	No or only PDF reports.	There is a structured and accessible public data portal.

Data collection involved multiple coders. Each local government website was assigned to one coder only, so that every website was independently evaluated by a single coder using the same standardized coding manual and checklist. Before the coding process, all coders participated in a calibration session to ensure a common understanding of the operational definitions and scoring criteria for each indicator. Any uncertainties encountered during coding were discussed collectively with the research team to maintain consistency in the application of the coding guidelines. Because each website was coded by only one assigned coder rather than being independently coded by multiple coders, formal inter-rater reliability statistics (e.g., Cohen's Kappa or Fleiss' Kappa) were not calculated.

Despite the absence of a statistical inter-coder reliability measure, several procedural safeguards were implemented to minimize subjectivity. First, all indicators were operationalized as dichotomous variables (0/1) based on directly observable website features, thereby reducing interpretive ambiguity. Second, the study employed a standardized and detailed codebook to ensure consistent interpretation and scoring across coders. Third, initial coordination and

collective discussions were conducted to clarify indicator definitions and resolve potential ambiguities prior to data collection. Accordingly, measurement consistency and reliability were maintained despite the absence of formal inter-rater reliability statistics.

To facilitate interpretation and descriptive comparison, transparency index scores were classified into four transparency levels: Low, Moderate, Good, and Very Good. The classification thresholds were determined based on score intervals within the theoretical range of the index (0–1), allowing transparency performance to be interpreted in qualitative terms. This classification approach supports clearer communication of results and enables the identification of general transparency patterns across local governments without altering the underlying index values.

Table 3. Transparency Index Classification Levels

Index Range	Transparency Level
0,00 – 0,49	Low
0,50 – 0,69	Moderate
0,70 – 0,84	Good
0,85 – 1,00	Very Good

This study incorporates a comparative analysis to examine whether differences exist between metropolitan and non-metropolitan cities in terms of website-based public service transparency index scores. The transparency index represents a composite measure derived from the assessment of multiple dimensions and indicators of public service transparency implemented through official local government websites (Cucciniello et al., 2020). These indicators capture key transparency attributes, including the availability, accessibility, and completeness of service-related and financial information.

For analytical purposes, cities are classified into metropolitan and non-metropolitan categories based on administrative and functional regional characteristics, such as population concentration, economic activity, and governance complexity. This regional classification is operationalized as a binary variable, where metropolitan cities are coded as 1 and non-metropolitan cities are coded as 0.

Given the relatively small sample size and the non-normal distribution of transparency index scores, this study employs the Mann–Whitney U test as a non-parametric statistical method (Field, 2018; Pallant, 2020). The test is used to assess whether statistically significant differences exist in the distribution of transparency index scores between the two groups. The comparative analysis is conducted at the aggregate index level to maintain analytical consistency and avoid over-fragmentation across dimensions. The effect size (r) was calculated using the formula $\frac{r=|Z|}{\sqrt{N}}$, where Z is the standardized test statistic and N is the total number of observations (Field, 2018).

4. Result

This section presents the empirical findings of the ICT Infrastructure–Based Public Service Transparency Index derived from the systematic evaluation of 16 Smart City local government websites. The results are organized sequentially, beginning with descriptive statistics

of the overall index, followed by inter-government comparisons, sensitivity checks, indicator and dimension-level analyses, and concluding with a comparative test between metropolitan and non-metropolitan cities.

Descriptive statistical analysis was conducted to summarize the distribution of transparency index scores across the 16 local governments included in the study. The descriptive measures reported include the minimum value, maximum value, mean, median, and standard deviation.

Table 4. Descriptive Statistics of the Public Service Transparency Index

Statistic	Value
Sample Size (N)	16
Minimum	0,75
Maximum	0,92
Mean	0,88
Median	0,92
Standard Deviation	0,05

The results show that transparency index scores range from 0.75 to 0.92, with a mean value of 0.88 and a median of 0.92. The relatively low standard deviation of 0.05 indicates limited variability across local governments. Based on the predefined classification thresholds, the index scores were categorized into four transparency levels: Low (0.00–0.49), Moderate (0.50–0.69), Good (0.70–0.84), and Very Good (0.85–1.00).

Table 5. Transparency Index Scores and Rankings of Local Governments

Name of Regional Government Area	Ranking	Transparency Index	Transparency Level
DKI Jakarta	1	0,92	Very Good
Yogyakarta	2	0,92	Very Good
Malang	3	0,92	Very Good
Denpasar	4	0,92	Very Good
Bogor	5	0,92	Very Good
Bekasi	6	0,92	Very Good
Magelang	7	0,92	Very Good
Solo	8	0,92	Very Good
Cimahi	9	0,92	Very Good
Surabaya	10	0,83	Good
Bandung	11	0,83	Good
Makassar	12	0,83	Good
Medan	13	0,83	Good
Palembang	14	0,83	Good
Salatiga	15	0,83	Good
Semarang	16	0,75	Good

The results indicate variations in Transparency Index scores across local governments. Nine local governments, namely DKI Jakarta, Yogyakarta, Malang, Denpasar, Bogor, Bekasi, Magelang, Solo, and Cimahi, share the highest Transparency Index score of 0.92 and are classified in the Very Good transparency category. Furthermore, six local governments, namely Surabaya, Bandung, Makassar, Medan, Palembang, and Salatiga, are classified in the Good transparency category with an index score of 0.83. Meanwhile, Semarang ranks lowest with a

Transparency Index score of 0.75, although it is still included in the Good category. No local governments fall into the Medium or Low transparency categories based on the established classification thresholds.

To facilitate the subsequent robustness analysis, the overall transparency rankings are presented separately in Table 6. These rankings serve as the baseline for comparison with the alternative ranking generated using the dimension-based aggregation approach presented in Table 7.

Table 6. Website Ranking Based on Transparency Index Scores

Name of Regional Government Area	Ranking
DKI Jakarta	1
Yogyakarta	2
Malang	3
Denpasar	4
Bogor	5
Bekasi	6
Magelang	7
Solo	8
Cimahi	9
Surabaya	10
Bandung	11
Makassar	12
Medan	13
Palembang	14
Salatiga	15
Semarang	16

The results indicate differences in transparency index scores across websites, with uneven distribution across index levels.

Robustness Check: Sensitivity Analysis of Rankings

Table 7. Sensitivity Analysis of Local Government Rankings

Name of Regional Government	Ranking of Indicators	Ranking of Dimensions
DKI Jakarta	1	1
Yogyakarta	2	2
Malang	3	3
Denpasar	4	4
Bogor	5	13

Bekasi	6	5
Magelang	7	6
Solo	8	7
Cimahi	9	8
Surabaya	10	10
Bandung	11	11
Makassar	12	12
Medan	13	15
Palembang	14	16
Salatiga	15	9
Semarang	16	14

A sensitivity analysis compares local government (LG) rankings derived from indicator-based aggregation with rankings derived from dimension-based aggregation. The comparison shows that the overall ranking structure remains similar across the two aggregation approaches, although changes in ranking positions are observed for several LGs.

LGs with consistently high rankings, including Jakarta, Yogyakarta, Malang, and Denpasar, show no change in ranking position under the two aggregation methods. In contrast, several LGs experience changes in ranking positions when the aggregation approach is altered. Bogor shifts from 5th place under the indicator-based aggregation to 13th place under the dimension-based aggregation. Salatiga moves from 15th place to 9th place across the two ranking approaches. Bekasi, Magelang, Solo, and Cimahi each experience minor changes of one to two ranking positions.

For LGs positioned in the middle-to-lower range of the rankings, including Medan and Palembang, differences in ranking positions are also observed between the indicator-based and dimension-based aggregations. These shifts are reflected in the comparative ranking results reported under the two aggregation methods.

Indicator-Level Transparency Analysis

To identify specific transparency strengths and gaps, an indicator-level frequency analysis was conducted across 16 local government websites that studied. This analysis distinguishes between indicators associated with basic compliance-oriented transparency and those reflecting operational, user-centered transparency.

Table 8. Frequency of Transparency Indicators across Local Government Websites

Indicator Transparency	Number of Websites	Percentage
Online Public Services	16	100%
Digital Service Forms	13	81.25%

Official Complaint Channel	16	100%
Complaint Flow / Follow-up	14	87.50%
Clear Service Contact	16	100%
Service Hours and Units	6	37.50%
Public Budget Information	16	100%
Downloadable Budget Documents	15	93.75%
Updated Budget Information	16	100%
Latest News Updates	16	100%
Program / Policy Information	11	68.75%
Open Data Portal	13	81.25%

Several indicators were consistently present across all evaluated local government websites, each appearing on 100% of the sample (16 out of 16 websites). These indicators include online public services, official complaint channels, clear service contact information, public budget information, updated budget information, and the provision of latest news updates. The universal presence of these indicators demonstrates that these transparency features were consistently available across all evaluated websites.

A high level of availability was also observed for downloadable budget documents, which were identified on 93.75% of websites (15 local governments). Indicators related to complaint handling mechanisms, specifically the availability of complaint flow or follow-up information, appeared on 87.50% of websites (14 local governments).

Moderate levels of availability were found for digital service forms and open data portals, each of which appeared on 81.25% of websites (13 local governments). Program or policy information was available on 68.75% of websites (11 local governments). The lowest level of availability was observed for the indicator related to service hours and responsible service units, which appeared on only 37.50% of websites (6 local governments).

To examine the distribution of transparency scores across different aspects of public service transparency, indicator scores were aggregated and normalized at the dimension level. As described in the methodology section, the public service transparency index is composed of six dimensions: (1) digital public services, (2) complaint handling and public participation, (3) service contact and accessibility, (4) budget transparency, (5) public information and updates, and (6) open data. Each dimension comprises a different number of indicators.

To ensure comparability across dimensions, the score for each dimension was normalized by dividing the total score obtained for that dimension by its maximum possible score. The resulting normalized scores enable comparison of dimension-level transparency results across the six dimensions.

Formally, the dimension score was calculated using the following formula:

$$\text{Dimension Score} = \frac{\text{Total indicator scores within a dimension}}{\text{Number of indicators} \times \text{Number of local governments}}$$

Table 9. Average Transparency Scores by Dimension

No	Dimensions Transparency	Amount Indicators	Average Score (%)
1	Digital Public Services	2	90.63
2	Public Complaints & Participation	2	93.75
3	Contact & Service Access	2	68.75
4	Budget Transparency	3	97.92
5	Public Information & Updates	2	84.38
6	Open Data	1	81.25

The dimensions of digital public services, complaint handling and public participation, and budget transparency recorded higher average scores compared to the other dimensions. In contrast, the dimensions of service contact and accessibility and open data recorded lower average scores.

Within the service contact and accessibility dimension, lower scores were associated with the limited presence of indicators related to operational service information, including service hours and responsible organizational units. For the open data dimension, lower scores were associated with the limited availability of structured and consistently accessible open data portals across local government websites. Variations in open data availability across local governments have also been documented in prior empirical studies, which report differences in data governance capacity and institutional readiness as observable characteristics of open data implementation.

Table 10. Transparency Dimension Scores across Local Governments

Name of Regional Government Area	Dimensions					
	Digital Public Services	Public Complaints & Participation	Contact & Service Access	Budget Transparency	Public Information & Updates	Open Data
DKI Jakarta	1,00	1,00	0,50	1,00	1,00	1,00
Surabaya	0,50	1,00	1,00	1,00	0,50	1,00
Bandung	1,00	1,00	0,50	1,00	0,50	1,00
Semarang	1,00	0,50	0,50	1,00	0,50	1,00
Yogyakarta	1,00	1,00	0,50	1,00	1,00	1,00
Malang	1,00	1,00	0,50	1,00	1,00	1,00
Denpasar	1,00	1,00	1,00	1,00	0,50	1,00
Makassar	1,00	0,50	0,50	1,00	1,00	1,00
Medan	1,00	1,00	0,50	1,00	1,00	0,00
Palembang	1,00	1,00	0,50	1,00	1,00	0,00
Bogor	1,00	1,00	1,00	1,00	1,00	0,00
Bekasi	1,00	1,00	1,00	1,00	0,50	1,00
Salatiga	0,50	1,00	1,00	0,67	1,00	1,00

Magelang	0,50	1,00	1,00	1,00	1,00	1,00
Solo	1,00	1,00	0,50	1,00	1,00	1,00
Cimahi	1,00	1,00	0,50	1,00	1,00	1,00

The heatmap visualizes transparency achievement across dimensions using color intensity. Darker colors represent higher transparency scores, while lighter colors represent lower transparency scores. The visualization displays variation in color intensity across dimensions, indicating differences in transparency scores among the evaluated dimensions.

Across the heatmap, dimensions related to digital public services, complaint handling and public participation, and budget transparency exhibit darker color intensities, reflecting higher scores. In contrast, the dimensions of service contact and accessibility and open data exhibit lighter color intensities, reflecting lower scores. The heatmap provides a comparative overview of transparency scores across dimensions based on their relative color intensities.

Comparative Analysis: Metropolitan vs Non-Metropolitan Cities

The analysis compares transparency index scores between metropolitan and non-metropolitan cities.

Classification of Research Objects

For the purpose of the comparison, the research objects are classified into two groups based on regional classification: metropolitan cities and non-metropolitan cities. The metropolitan group consists of local governments classified as metropolitan cities, while the non-metropolitan group consists of local governments classified as non-metropolitan cities. This grouping is used to organize the comparative analysis of transparency index scores between the two categories.

Table 11. Classification of Metropolitan and Non-Metropolitan Cities

Name of Regional Government	Index	Classification
DKI Jakarta	0,92	1
Yogyakarta	0,92	0
Malang	0,92	0
Denpasar	0,92	0
Bogor	0,92	1
Bekasi	0,92	1
Magelang	0,92	0
Solo	0,92	0
Cimahi	0,92	0
Surabaya	0,83	1
Bandung	0,83	1
Makassar	0,83	1
Medan	0,83	1

Palembang	0,83	0
Salatiga	0,83	0
Semarang	0,75	0

The table presents the classification of cities included in the analysis. Each city is assigned a binary code to indicate its classification status, where a value of 1 represents metropolitan cities and a value of 0 represents non-metropolitan cities. This classification is used to distinguish between the two groups for subsequent descriptive and inferential analyses.

Descriptive Statistics by Regional Classification

To present descriptive statistics of website-based transparency index scores for metropolitan and non-metropolitan cities.

	Metro	N	Ranks	
			Mean Rank	Sum of Ranks
Indeks	0	9	9.11	82.00
	1	7	7.71	54.00
	Total	16		

Figure 2. Descriptive Statistics of Transparency Index Scores by Regional Classification

Figure 1 presents the descriptive statistics of transparency index scores by regional classification. Non-metropolitan local governments ($n = 9$) obtained a higher mean rank (9.11) than metropolitan local governments ($n = 7$), which had a mean rank of 7.71. However, these descriptive differences in mean rank do not necessarily indicate statistical significance. Therefore, a Mann–Whitney U test was conducted to determine whether the observed difference between the two groups was statistically significant.

A Mann–Whitney U test was conducted to compare transparency index scores between metropolitan and non-metropolitan local governments. This non-parametric test was used to examine whether the observed differences in transparency index scores between the two groups were statistically significant

Test Statistic ^a	
	indeks
Mann–Whitney U	26.000
Wilcoxon W	54.000
Z	-.663
Asymp. Sig. (2-tailed)	.508
Exact Sig. [2 × (1-tailed Sig.)]	.606 ^b

a. Grouping Variable: metro.

b. Not corrected for ties.

Figure 3. Mann–Whitney U Test Results for Transparency Index Scores

The Mann–Whitney U test indicated no statistically significant difference in transparency index scores between metropolitan and non-metropolitan local governments ($U = 26.00$, $Z = -0.663$, asymptotic $p = 0.508$). The mean ranks were 7.71 for metropolitan local governments ($n = 7$) and 9.11 for non-metropolitan local governments ($n = 9$). The calculated effect size was small ($r = 0.17$), indicating that the magnitude of the difference between the two groups was negligible. Therefore, the null hypothesis was not rejected, suggesting that regional classification was not associated with statistically significant differences in website-based public service transparency. Similar patterns of non-significant differences in digital transparency outcomes across regional classifications have also been reported in prior empirical studies.

5. Discussions and Conclusions

The findings of this study provide empirical insights into how local government websites function as ICT-enabled service infrastructure for public service transparency within the Smart City context. Overall, the results indicate relatively limited variation in overall transparency performance across local governments, while more noticeable differences emerge across transparency dimensions, suggesting that digital public service transparency is developed unevenly at the dimension level.

Similar dimension-specific differences have also been reported internationally. Worthy and Waugh (2024) argue that despite long-standing efforts to improve transparency through Freedom of Information (FOI) legislation and open data initiatives, local governments continue to differ in the implementation of specific transparency practices due to variations in institutional capacity, governance arrangements, and implementation strategies. This observation is consistent with the findings of the present study, which indicate relatively consistent overall transparency performance across local governments but more noticeable differences across transparency dimensions.

Consistent with expectations derived from the literature, information-oriented transparency dimensions particularly budget transparency and public information updates—exhibited relatively higher scores compared to other dimensions. This pattern aligns with previous studies, including (Fietkiewicz et al., 2017), which demonstrate that information dissemination functions tend to reach higher levels of maturity earlier than interactive or participatory features on e-government websites. Strong performance in the availability of budget information, downloadable budget documents, and regularly updated news content reflects the influence of formal regulatory requirements and administrative routines that mandate public information disclosure. These features generally require lower levels of organizational coordination and pose fewer technical challenges than interactive or transaction-based service components.

This observed pattern has direct implications for accountability research. Document-based transparency on local government websites such as APBD summaries, downloadable budget documents, and updated fiscal information should not be understood merely as information availability, but as a mechanism that supports fiscal accountability and public monitoring. By making budget documents visible and accessible, websites provide verifiable evidence that can be examined by citizens, auditors, and oversight bodies, thereby strengthening the control environment through clearer expectations regarding disclosure and audit trails. However, persistent weaknesses in access to operational information reveal a service

accountability gap. Although fiscal information has been widely disclosed, citizens may still face uncertainty when accessing services or identifying responsible service units. This finding reinforces the argument that transparency in smart governance should be evaluated through both fiscal/document accountability and operational/service accountability.

In contrast, dimensions related to service accessibility and operational transparency such as the availability of service hours, clarity regarding responsible service units, and the provision of well-structured service procedures—exhibited lower and more uneven scores. These findings suggest that while local governments may prioritize making information publicly available, they often fall short in providing detailed, user-oriented guidance that enables citizens to effectively navigate public services. From a smart governance perspective, this gap indicates that transparency is frequently treated as a compliance-driven obligation rather than as a user-centered service function.

Findings related to complaint and participation mechanisms further reinforce this interpretation. Although most local government websites provide formal complaint channels, only a limited number clearly explain complaint procedures, response timeframes, or follow-up mechanisms. This pattern is consistent with the observations of Fietkiewicz et al. (2017), who found that participatory and interactive features tend to lag behind informational components in smart city government websites. These results highlight that the mere presence of digital channels does not guarantee meaningful transparency or accountability unless supported by clear procedures and explicit institutional commitments.

The open data dimension demonstrates the highest level of variability among local governments. While some websites offer structured and accessible open data portals, others rely solely on static documents or provide no open data access at all. This variation reflects differences in institutional capacity, data governance readiness, and transparency priorities. From a boundary object perspective, open data functions require coordination across multiple organizational units and are therefore more sensitive to internal governance structures than basic information disclosure.

This finding is consistent with the OECD (2023), which emphasizes that open data has become a core component of smart city governance because it enhances transparency, accountability, and evidence-based policymaking. The report also highlights that the effectiveness of open data initiatives depends on institutional capacity and sound data governance, which may explain the variation observed across local government websites in this study.

Overall, these findings support the conceptualization of local government websites as boundary objects, as proposed by Fietkiewicz et al. (2017). As boundary objects, government websites are generally effective in accommodating basic informational needs across diverse user groups but encounter challenges in consistently supporting more complex, interaction-intensive transparency functions. This reinforces the argument that transparency in Smart City governance should not be assessed solely based on the existence of digital platforms, but rather on the functional capabilities these platforms provide to citizens.

From a methodological perspective, the proposed ICT Infrastructure–Based Public Service Transparency Index provides a practical and replicable benchmarking tool for evaluating

website-based public service transparency and complements existing macro-level e-government assessments.

Conclusion

This study examined public service transparency on Smart City local government websites by developing and applying an ICT Infrastructure–Based Public Service Transparency Index. The results demonstrate relatively limited variation in overall transparency performance across local governments, while more pronounced differences exist across transparency dimensions. Information-oriented features such as budget disclosure, downloadable financial documents, and regularly updated public information—are generally more consistently available, while operational and service-oriented transparency features remain less developed.

The findings indicate a structural imbalance between document-based transparency and service accountability. Although compliance-driven disclosure of fiscal information contributes positively to fiscal accountability and public monitoring, limited transparency in service accessibility, procedural clarity, and participatory mechanisms constrains user-oriented accountability. This suggests that the existence of digital platforms alone is insufficient to achieve smart governance; transparency must also support citizens' practical ability to access and navigate public services. In this respect, the findings reinforce the argument that local government websites function not only as informational boundary objects but also as accountability mechanisms that strengthen fiscal transparency, public oversight, and auditability within the framework of public sector accounting (Fietkiewicz et al., 2017).

Limitations of Research

This study has several limitations. First, although data collection involved multiple coders, each local government website was evaluated by only one assigned coder. Consequently, formal inter-rater reliability statistics could not be calculated. Nevertheless, standardized coding guidelines, a detailed codebook, and coder calibration discussions were implemented to minimize subjectivity and enhance consistency throughout the coding process. Second, the study captures transparency at a specific observation period and does not account for temporal changes in website content. These limitations may affect the generalizability of the findings, particularly with respect to the dynamic nature of digital public service platforms.

Future research may address these limitations by incorporating longitudinal designs, involving multiple coders, and integrating user-centered evaluations to assess not only the presence but also the usability and effectiveness of transparency features. Such approaches would deepen understanding of how ICT-enabled infrastructure can more fully support service accountability within Smart City governance.

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