

Engineering Mobile-First G2C Portal Via PWA: A Pre-Post WebQual 4.0 and IPA Guided Prototyping Framework

*Putri Teja Kencana ¹⁾, Rika Apriani ²⁾

¹⁾²⁾Department of Informatics Management, Universitas Bina Insani

^{*)}Correspondence author: putriteja@studentbinainsani.ac.id, Bekasi, Indonesia

DOI: <https://doi.org/10.37012/jtik.v12i2.3591>

Abstract

Indonesian sub-national e-government portals are often delivered by vendors as completed systems without documentation, leaving local governments unable to maintain or further develop them safely. The Bekasi Keren portal (kotabekasikeren.com) represented this situation. An initial evaluation involving 52 city residents using the WebQual 4.0 framework produced a Grand Mean of 3.210, indicating Moderate quality across all 15 indicators. Importance–Performance Analysis (IPA) identified six indicators in Quadrant I, representing high-priority aspects requiring immediate improvement. Rather than proposing recommendations alone, this study reconstructed the portal based on those findings. The redesigned system was developed using Firebase Cloud Functions (Express.js), Google Cloud Firestore, and a Bootstrap 5 Multi-Page Application frontend to minimize loading overhead on low-end Android devices. Two interaction features absent from the original portal were introduced: a one-tap reaction mechanism secured with SHA-256 session hashing (NIST FIPS 180-4) to ensure idempotency, and a public comment system allowing submissions without account registration through IP-based rate limiting and administrator moderation. Functional testing confirmed that all 17 test scenarios passed successfully. A post-deployment evaluation involving 62 residents recorded a Grand Mean of 4.374 (Very High), representing a 36.3% improvement over the initial assessment. Usability increased by 1.230 points, Information Quality by 1.067, and Service Interaction Quality by 1.195. The largest improvement occurred in SI1 (Ease of Providing Feedback), which increased by 1.456 points and moved out of Quadrant I. These findings demonstrate that integrating Derived IPA with Prototyping provides an effective and practical approach for improving G2C portals in resource-constrained Indonesian local governments.

Keywords: E-Government, Importance–Performance Analysis, Progressive Web App, Prototyping, WebQual 4.0

Abstrak

Portal e-government pada tingkat pemerintah daerah di Indonesia sering kali diserahkan oleh vendor sebagai sistem yang telah selesai dibangun, tetapi tanpa dokumentasi yang memadai, sehingga pemerintah daerah kesulitan melakukan pemeliharaan maupun pengembangan lebih lanjut secara aman. Portal Bekasi Keren (kotabekasikeren.com) merupakan salah satu contoh kondisi tersebut. Evaluasi awal yang melibatkan 52 warga Kota Bekasi menggunakan kerangka WebQual 4.0 menghasilkan Grand Mean sebesar 3,210 yang menunjukkan kualitas pada kategori sedang untuk seluruh 15 indikator. Analisis Importance–Performance Analysis (IPA) mengidentifikasi enam indikator yang berada pada Kuadran I sebagai aspek prioritas yang memerlukan perbaikan segera. Alih-alih hanya memberikan rekomendasi, penelitian ini membangun kembali portal berdasarkan hasil evaluasi tersebut. Sistem yang dikembangkan menggunakan Firebase Cloud Functions (Express.js), Google Cloud Firestore, dan antarmuka Bootstrap 5 Multi-Page Application untuk meminimalkan beban pemuatan pada perangkat Android berspesifikasi rendah. Dua fitur interaksi yang sebelumnya tidak tersedia ditambahkan, yaitu mekanisme reaksi sekali ketuk yang diamankan dengan hashing sesi SHA-256 (NIST FIPS 180-4) untuk menjamin idempotensi, serta sistem komentar publik yang memungkinkan pengguna mengirimkan komentar tanpa membuat akun melalui pembatasan berbasis alamat IP dan moderasi oleh administrator. Pengujian fungsional menunjukkan bahwa seluruh 17 skenario pengujian berhasil dilalui. Evaluasi setelah implementasi yang melibatkan 62 warga menghasilkan Grand Mean sebesar 4,374 (Sangat Tinggi), meningkat 36,3% dibandingkan evaluasi awal. Dimensi Usability meningkat sebesar 1,230 poin, Information Quality sebesar 1,067 poin, dan Service Interaction Quality sebesar 1,195 poin. Peningkatan terbesar terjadi pada indikator SI1 (Kemudahan Memberikan Umpan Balik), yang naik sebesar

1,456 poin dan keluar dari Kuadran I. Temuan ini menunjukkan bahwa integrasi Derived IPA dengan metode Prototyping merupakan pendekatan yang efektif dan praktis untuk meningkatkan kualitas portal G2C pada pemerintah daerah di Indonesia yang memiliki keterbatasan sumber daya.

Kata Kunci: Analisis Kepentingan–Kinerja, Aplikasi Web Progresif, Pemerintahan Elektronik, Pembuatan Prototipe, WebQual 4.0

INTRODUCTION

Approximately 215 million Indonesians were using the internet by 2023, and data from APJII confirm that 78 percent of them did so through a smartphone (APJII, 2023). That single fact reshapes what a government portal needs to be. It is no longer enough for a portal to function on a desktop with a fast connection; the practical question is how it performs on a mid-range Android handset on a 4G signal in a crowded city. Presidential Regulation No. 95 of 2018 on the Electronic-Based Government System (SPBE) set out the ambition of digital services at every level of Indonesian government but left the execution details largely open, which means the quality of individual portals varies considerably (Reddick et al., 2023).

Bekasi offers a sharp example of what the execution gap looks like in practice. kotabekasikeren.com serves a city of roughly 3.4 million people, yet when this study began it was running on a codebase that the city's own technical staff could not modify: no architecture diagram had been provided, no database schema, no handover documentation of any kind (United Nations, 2022; Tambouris, 2012). Broken image links had accumulated over months. Although the initial visualization was monolithic, loading times for pages were slow. Upon a phone, layouts that seemed good on a 1080p monitor broke down. Besides that, a button in the code remained to encourage visitors to post publications on Google+, an online platform that was taken down in April 2019.

The cognitive cost of using a portal like this is easy to underestimate. Bawden and Robinson (2020) describe information overload partly as a function of presentation quality, not just information volume; when the interface itself demands attention broken elements to work around, layouts to reorient to the cognitive load Sweller et al. (2019) call extraneous rises and the load they call germane falls. For residents trying to find a permit form or a local news item, the design friction is not a minor inconvenience. It is the difference between completing the task and giving up (Kriswibowo et al., 2021; Barnes and Vidgen, 2002).

WebQual 4.0, introduced by Barnes and Vidgen (Barnes and Vidgen, 2002), provides a 15-item Likert instrument for assessing web quality across Usability, Information Quality, and Service Interaction Quality. When Martilla and James's Importance Performance Analysis (IPA) (Martilla and James, 1977) is layered on top, the output is not just a score but a ranked priority map: Quadrant I items are the ones that user's rate as most important while the portal is delivering them worst. Indonesian researchers have used this combination on government portals before (Septian et al., 2021; Rerung and Ramadhan, 2024). They have consistently found problems and recommended fixes. What none of them did was then build those fixes and return to the same population with the same instrument to check whether the scores moved. This study takes that step.

What came out of the work: a rebuilt portal whose architecture is fully documented and maintainable without vendor dependency; two new features a session-hashed reaction system and a no-login comment system that address the specific Quadrant I gaps in citizen interaction; and empirical confirmation that those features shifted the scores in the direction the IPA analysis predicted. The framework diagnosed with WebQual 4.0 and Derived IPA, built using Prototyping, re-measure is generic enough to transfer to other Indonesian municipal portals (Maulana et al., 2024), which is the point.

RESEARCH METHODS

The research project used a dual-phase sequential design, with WebQual 4.0 and IPA used for the detection phase and incremental prototyping used for the construction and evaluation phase. Below is a brief overview of each component.

Research Design

Phase 1 surveyed 52 active Bekasi residents with the WebQual 4.0 instrument and computed Derived IPA to rank the 15 quality indicators. Phase 2 used those ranked priorities to scope and sequence a Prototyping-based reconstruction (Pressman and Maxim, 2020; Sommerville, 2016) of the portal, then surveyed a second cohort of 62 residents with the identical instrument. Prototyping fit naturally here because its revision-per-cycle structure mirrors the prioritised list that IPA produces: address the Quadrant I items first, iterate, measure again. The evaluate–design–validate sequence is also the pattern recommended for quality-centred e-government work (Rindani and Puspitodjati, 2020), so the approach is methodologically grounded.

Prototyping Stages

Six stages structured the development. The first, Requirements Identification, combined the WebQual 4.0 baseline scores with direct observation of the live portal looking at what was broken, what was missing, and what users in the survey had rated poorly. Rapid Design followed, producing UML diagrams across six views: use case, activity, sequence, class, deployment, and component. Prototype Construction then implemented the architecture described in Section II-C. Three rounds of User Evaluation and Prototype Refinement followed each cycle tightening the interaction design and resolving defects found in the previous round. Deployment to `bekasi-keren.web.id` concluded the prototyping work and triggered the post-improvement survey, conducted four weeks after deployment to allow sufficient user exposure.

System Architecture

The redesigned site is based on a Routes-Controllers- Services (RCS) architecture that is implemented as Firebase Cloud Functions running Express.JS. HTML5, CSS3, and Bootstrap 5 were used to create the frontend as a Multi-Page Application (MPA). Since the object in question devices are moderately priced Android phones and removing the JavaScript bundle significantly reduces the beginning parsing time, MPA was chosen over a React or Vue SPA. Google Cloud Firestore handles persistence; queries use single-field where () clauses throughout, which avoids composite indexes and keeps the data layer simple enough for in-house staff to maintain without vendor support. Firebase Hosting delivers everything via CDN. Article CRUD, categories, responses and comments, moderating, and configuration are all covered via 17 REST endpoints throughout the system. The entire architecture of the system is shown in Figure 3.A.

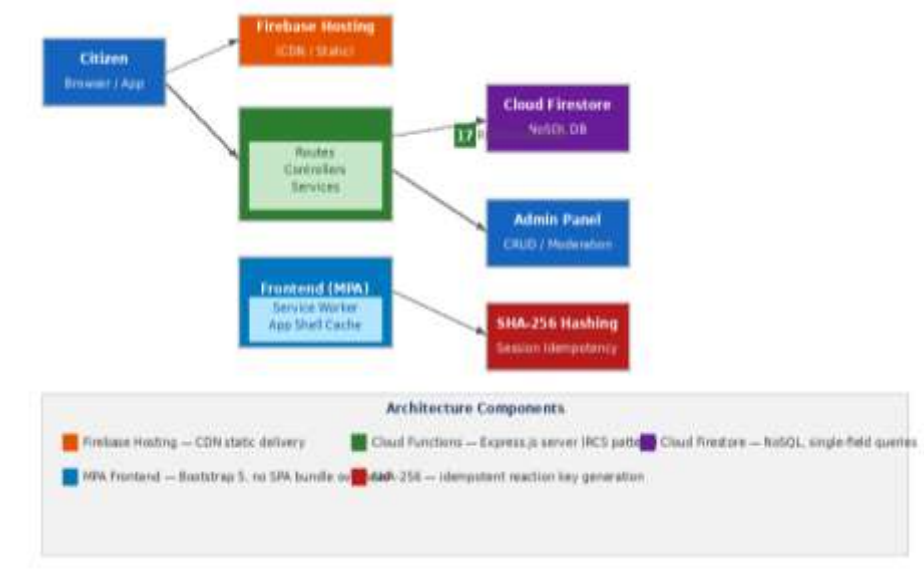


Figure 1. System Architecture of The Reconstructed Bekasi Keren Portal:
Routes-Controllers-Services on Firebase Cloud Functions

Citizen Interaction Features

The original portal offered no way for residents to respond to content. Two features were built to change that. The reaction system lets users tap a button once per article per session. Both the session token and article ID are hashed collectively using SHA-256 (NIST FIPS 180-4) (National Institute of Standards and Technology, 2015) in order to enforce idempotency; the hash forms the corresponding key, so successive taps from the same session condense to a single database write. No account is involved. Comments work similarly, no registration required. A server-side check limits each IP address to three submissions per hour, and every comment enters an admin moderation queue rather than publishing directly (Ramadhani and Pambudi, 2023). The goal was the lowest possible barrier to participation without opening the door to spam.

WebQual 4.0 Instrument and Sampling

The 15-item WebQual 4.0 questionnaire (Barnes and Vidgen, 2002) uses a five-point Likert scale (1 = Strongly Disagree, 5 = Strongly Agree) across three subscales: Usability (U1–U5), Information Quality (IQ1–IQ5), and Service Interaction Quality (SI1–SI5). Grand mean scores are interpreted using the interval classification in Table I.

Table 1.
Likert Scale Category Intervals Used for Grand Mean Classification

Score Range	Category	Interpretation
1.00 – 1.80	Very Low	Very poor quality; immediate overhaul needed
1.81 – 2.60	Low	Below expectations; significant gaps present
2.61 – 3.40	Moderate	Acceptable but with notable improvement areas
3.41 – 4.20	High	Generally satisfactory; minor improvements needed
4.21 – 5.00	Very High	Exceeds user expectations

Note: Adapted from standard five-interval Likert classification. Source: Primary data (2026).

Both surveys used the same instrument version with no modifications. A purposeful sampling technique was used to choose those who responded, who were residents who had accessed kotabekasikeren.com at least once in the 30 days before the poll. There were 52 people in the pre-improvement cohort and 62 in the post-improvement cohort. The demographic profile of both groups is shown in Table 2.

Table 2.
Summarises The Demographic Profile of Both Cohorts

Characteristic	Category	Pre-Improvement n (%)	Post-Improvement n (%)
Gender	Male	29 (55.8%)	35 (56.5%)
	Female	23 (44.2%)	27 (43.5%)
Age	18–25 years	18 (34.6%)	22 (35.5%)
	26–35 years	21 (40.4%)	25 (40.3%)
	36–45 years	9 (17.3%)	11 (17.7%)
	> 45 years	4 (7.7%)	4 (6.5%)
Access frequency	Daily	12 (23.1%)	17 (27.4%)
	2–4×/week	19 (36.5%)	24 (38.7%)
	Weekly	15 (28.8%)	16 (25.8%)
	Monthly or less	6 (11.5%)	5 (8.1%)
Device	Smartphone	46 (88.5%)	57 (91.9%)
	Desktop/Laptop	6 (11.5%)	5 (8.1%)

Note: Source: Primary data (2026).

Validity was checked using Corrected Item-Total Correlation every item cleared the r-table threshold of 0.273 at $N = 52$, $\alpha = 5\%$. Cronbach's Alpha was 0.873 -- 0.892 before the rebuild and 0.966 after, which Hair et al. (2019) place in the Excellent band.

Derived IPA Computation

Standard IPA asks respondents to rate both how important an attribute is and how well the site delivers it. The problem with stated importance is that nearly every attribute ends up rated 4 or 5 the scale compresses and loses discriminating power (Bacon, 2003). Derived Importance sidesteps this by inferring attribute weight from the data rather than asking for it directly: each indicator's importance score is its Pearson correlation with the respondent's total WebQual score, rescaled to 1–5 following the procedures in Bacon (Bacon, 2003) and Abalo et al. (2007). The IPA grid was then constructed with the grand mean as the axis crosspoint, and quadrant assignments were calculated independently for the pre- and post-improvement datasets so that movement across quadrants could be observed.

RESULTS AND DISCUSSION

This section contains the analysis, implementation or testing results, and a discussion of the research topic. The research methodology can be developed in advance. This section also provides explanations in the form of figures, tables, and other details.

Reconstructed Portal Interface

Usability shifted from 3.115 to 4.345, a gain of +1.230. The two items that moved most were U4 (Mobile Responsiveness, +1.255) and U5 (Loading Speed, +1.248). Both improvements trace directly to the same two decisions: Bootstrap 5's automatic viewport reflow, which eliminated the collapsed layouts that the original portal suffered on phones, and the App Shell caching strategy via Service Worker, which pre-renders the portal skeleton so that repeat visitors get near-instant first paint rather than waiting for the full server response.

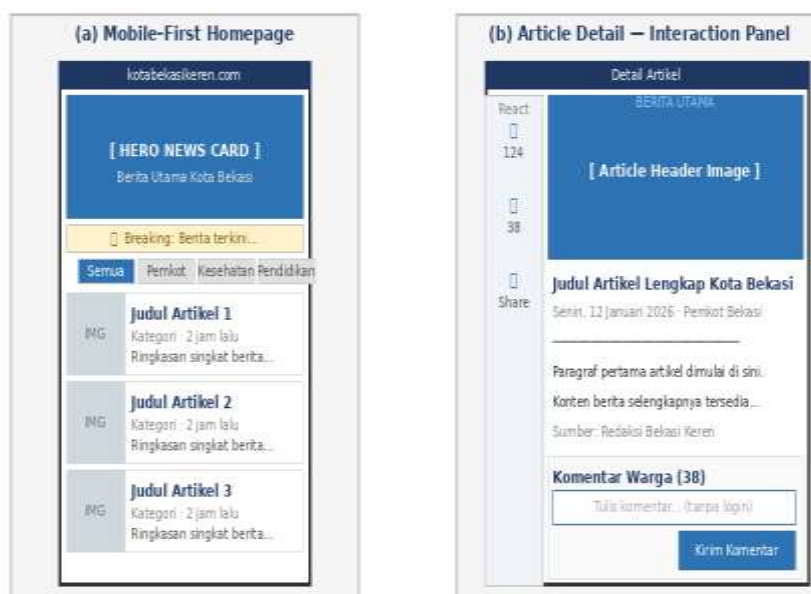


Figure 2. Reconstructed Bekasi Keren Portal: (a) Mobile-First Homepage with Hero Card, Ticker, and Category Navigation; (b) Article Detail Page with Interaction Panel (Reactions and Comments, No Login Required)

Black-Box Testing Results

Testing ran 17 scenarios covering the full surface of the system. Every scenario produced the expected output, giving a 100% pass rate. Table V provides the complete functional test log.

Table 3.
Black-Box Functional Test Results (17 Scenarios)

No.	Test Scenario	Expected Output	Status
1	Article listing with pagination	Articles displayed in pages of 10	✓ Pass
2	Article detail rendering	Full content, metadata, media load	✓ Pass
3	Category filtering	Only articles in selected category shown	✓ Pass
4	Adaptive full-text search (Fuse.js)	Relevant results returned for keyword	✓ Pass
5	Breaking-news ticker display	Latest 5 headlines rotate correctly	✓ Pass
6	Reaction submission first tap	Reaction count increments by 1	✓ Pass
7	Reaction idempotency repeat tap same session	Count unchanged; no DB duplicate	✓ Pass
8	Reaction from different session	Count increments independently	✓ Pass
9	Comment submission within rate limit	Comment queued for moderation	✓ Pass
10	Comment rate limit enforcement (>3/hr/IP)	429 error returned; submission blocked	✓ Pass
11	Admin authentication	Valid credentials grant dashboard access	✓ Pass
12	Admin authentication invalid credentials	Access denied, error message shown	✓ Pass
13	Article CRUD Create	New article stored and retrievable	✓ Pass

14	Article CRUD	Update	Changes persisted correctly	✓ Pass
15	Article CRUD	Delete	Article removed from listing	✓ Pass
16	Comment moderation	Hide	Comment hidden from public view	✓ Pass
17	Video of the Day management		Video updated and displayed correctly	✓ Pass

Note: All 17 scenarios achieved Pass status. SHA-256 idempotency (Scenarios 7–8) confirmed zero duplicate database entries across 50 repeated submissions per session. Source: Primary data (2026).

WebQual 4.0 Analysis: Dimension-Level Comparison

Full indicator-level results are in Table VI; dimension summaries are in Table VII. The Δ column reports post minus pre arithmetic differences, each verified against the raw item means.

Table 4.
Complete WebQual 4.0 Pre- vs. Post-Improvement Results (N Pre = 52; N Post = 62)

Code	Indicator	Dim.	Pre	Post	Δ	Q Pre	Q Post
U1	Navigation Ease	Usability	3.154	4.436	+1.282	I	II
U2	Visual Presentation	Usability	3.115	4.516	+1.401	III	IV
U3	Instruction Clarity	Usability	3.231	4.194	+0.963	II	I*
U4	Mobile Responsiveness	Usability	3.019	4.274	+1.255	I	I
U5	Loading Speed	Usability	3.058	4.306	+1.248	I	I
IQ1	Information Accuracy	Info. Q.	3.365	4.564	+1.199	IV	IV
IQ2	Information Currency	Info. Q.	3.365	4.258	+0.893	IV	IV
IQ3	Information Relevance	Info. Q.	3.327	4.323	+0.996	III	IV
IQ4	Visualisation/Infographics	Info. Q.	3.173	4.387	+1.214	III	IV
IQ5	Language Comprehensibility	Info. Q.	3.385	4.419	+1.034	IV	IV
SI1	Ease of Feedback†	Svc. Int.	3.173	4.629	+1.456	I	II
SI2	Admin Response Speed	Svc. Int.	3.096	4.097	+1.001	I	I
SI3	Personal Data Security	Svc. Int.	3.115	4.274	+1.159	III	III
SI4	Brand Identity (KEREN)	Svc. Int.	3.192	4.468	+1.276	I	II
SI5	Trust and Civic Pride	Svc. Int.	3.385	4.468	+1.083	IV	IV

Note: Q = IPA Quadrant. Δ = Post – Pre (arithmetic, verified). Grand Mean pre = 48.153/15 = 3.210; post = 65.613/15 = 4.374; gain = 36.3%. † SI1: largest individual Δ . * U3 entered Quadrant I post-improvement. Derived Importance per Bacon (2003). Source: Primary data (2026).

Usability shifted from 3.115 to 4.345, a gain of +1.230. The two items that moved most were U4 (Mobile Responsiveness, +1.255) and U5 (Loading Speed, +1.248). Both improvements trace directly to the same two decisions: Bootstrap 5's automatic viewport

reflow, which eliminated the collapsed layouts that the original portal suffered on phones, and the App Shell caching strategy via Service Worker, which pre-renders the portal skeleton so that repeat visitors get near-instant first paint rather than waiting for the full server response. U1 (Navigation Ease, +1.282) also left Quadrant I, which validates the 3-click maximum enforced on all mobile navigation paths.

Information Quality landed at 4.390 after starting at 3.323. IQ1 (Information Accuracy) reached 4.564 the highest individual post-improvement score in its dimension largely because the editorial workflow was restructured to require explicit source attribution, a publication date, and a category tag on every article before it can be published. IQ2 (Information Currency, 4.258) was the lowest scorer in Information Quality after the rebuild, and Wang and Strong's (Wang and Strong, 1996) observation that users weight timeliness heavily explains why. How often articles are published is an editorial staffing question, not something the system itself can fix. Compared to similar Indonesian G2C portal studies Septian et al. (2021) reported post-intervention scores around 3.8–4.1 and Rerung and Ramadhan (Rerung and Ramadhan, 2024) around 3.9 the 4.390 recorded here suggests the IPA-sequenced approach yields relatively higher gains, though direct comparison is complicated by contextual differences between portals.

Service Interaction Quality produced the number that most surprised the author during analysis. SI1 Ease of Providing Feedback rose from 3.173 to 4.629, a +1.456 gain that is the largest of any single indicator in either survey. The reason, on reflection, is less surprising: the original portal had no mechanism for feedback at all. Adding a comment box and a reaction button to a system that previously offered neither is not a subtle change from the user's perspective; it is the difference between being heard and being ignored. Panjaitan et al. (2023) argued that Service Interaction Quality is structurally resistant to engineering improvements because it depends on human response speed. That argument has merit when interaction channels already exist. When they do not, the engineering layer is what creates the precondition for any interaction to happen. The present data support this reading, and the pattern aligns with what Maulana et al. (2024) find in the broader e-participation literature: friction reduction correlates with perceived trustworthiness.

IPA Quadrant Analysis

Figure 3 shows the post-improvement IPA matrix. Table VIII details indicator-level quadrant migration.

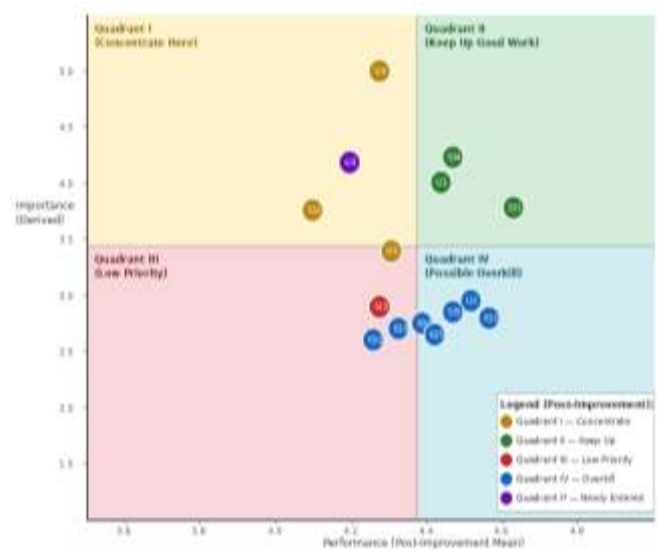


Figure 3. IPA Matrix – Post Improvement Indicator Positions

Figure 3. IPA matrix showing post-improvement indicator positions. Quadrant I (top-left, amber): concentrate here. Quadrant II (top-right, green): keep up good work. Quadrant III (bottom-left, red): low priority. Quadrant IV (bottom-right, blue): possible overkill.

Table 5.
Baseline Quadrant I Indicators and Post-Improvement Quadrant Migration

Code	Indicator	Importance	Pre-Perf.	Post Perf.	Quadrant Shift and Interpretation
U1	Navigation Ease	4.007	3.154	4.436	I → II: 3-click hierarchy resolved priority gap
U3	Instruction Clarity	4.188	3.231	4.194	II → I*: newly entered; target for next iteration
U4	Mobile Responsiveness	5.000	3.019	4.274	I → I: highest importance; cold start residual
U5	Loading Speed	3.395	3.058	4.306	I → I: App Shell +1.248; cold start persists
SI1	Ease of Feedback†	3.778	3.173	4.629	I → II: +1.456; login-free comment and reaction
SI2	Admin Response Speed	3.760	3.096	4.097	I → I: editorial SOP issue; outside system scope
SI4	Brand Identity (KEREN)	4.233	3.192	4.468	I → II: Mobile-First design reinforces brand identity

Note: Dimension means verified: Usability pre 15.577/5=3.115, post 21.726/5=4.345; Info. Quality pre 16.615/5=3.323, post 21.951/5=4.390; Svc. Interaction pre 15.961/5=3.192, post 21.936/5=4.387. Source: Primary data (2026).

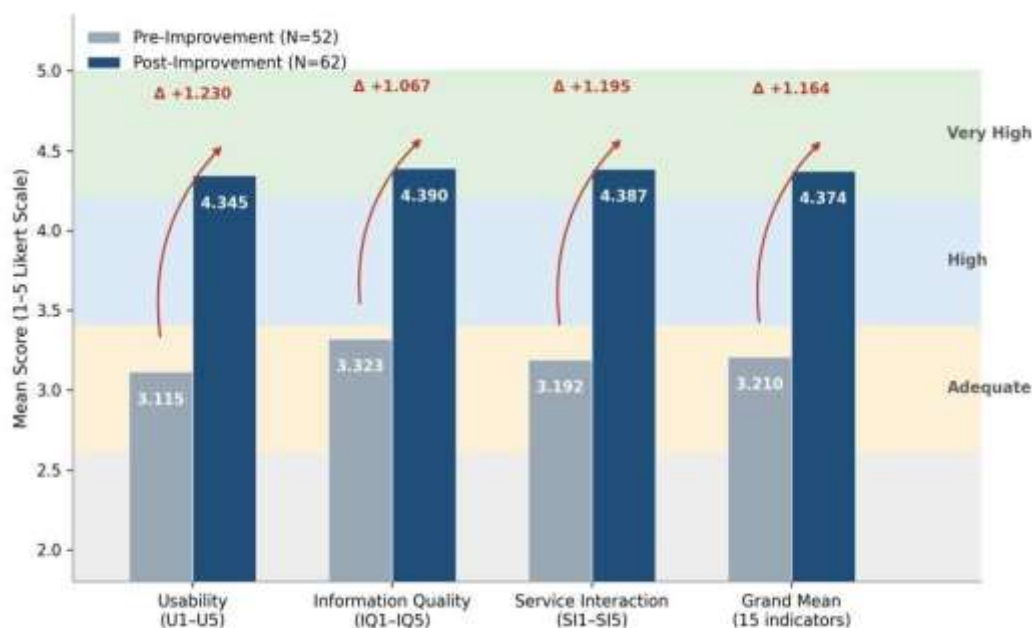


Figure 4. Comparison of Pre-Improvement and Post-Improvement Mean Scores Across Usability, Information Quality, Service Interaction, and Overall Performance

Three of the original seven Quadrant I indicators moved to Quadrant II: U1, SI1, and SI4. Two stayed put. U5 (Loading Speed) improved by +1.248 but Firebase Cloud Functions imposes a cold-start penalty on the first request of each session (Golec, 2025) that continues to depress user perception of speed even after caching kicks in on subsequent requests. Minimum instance provisioning is the straightforward remedy. SI2 (Admin Response Speed) stayed in Quadrant I for a reason that no frontend change can address: it measures how quickly the editorial team replies to submitted content, and that is a staffing and process question.

One movement that was not anticipated: U3 (Instruction Clarity) migrated into Quadrant I after the rebuild, having started in Quadrant II. This appears to be a consequence of the new interface raising user expectations; better usability overall makes the remaining unclear instructions more salient, not less. It is the kind of result that only becomes visible when the evaluation loop is closed, and it gives the next development iteration a clear starting point. These findings add an implementation layer to a body of G2C WebQual research (Septian et al., 2021; Rindani and Puspitodjati, 2020; Rerung and Ramadhan, 2024) that has until now stopped at diagnosis, and document a serverless deployment pattern (Madaminov and Allaberganov, 2023; Aslan et al., 2022) that in-house teams can maintain without vendor dependency which was the original problem.

CONCLUSION AND RECOMMENDATION

The Bekasi Keren portal was unmaintainable when this study began. Six quality indicators sat in IPA Quadrant I. The Grand Mean was 3.210. After a documented, phased rebuild

guided by those IPA priorities, the Grand Mean reached 4.374 a 36.3% increase confirmed across all three WebQual dimensions and verified against the raw item arithmetic. Every scenario in the black-box test suite passed.

The finding that holds the most practical weight is SI1. A +1.456-point gain on Ease of Providing Feedback the largest shift in the dataset came from adding a comment box and a like button to a portal that previously had neither. The literature has generally treated Service Interaction Quality as an organisational problem: improve it by making staff more responsive. What the SI1 result suggests instead is that in cases where no interaction channel exists at all, giving residents a way to respond is itself the primary intervention. The organisational question of how quickly administrators reply is secondary to whether residents can speak in the first place. That is a different causal story, and it has different implications for where portal improvement budgets should go first.

Several limitations should be on the record. The pre- and post-improvement surveys drew from independent samples ($N = 52$ and $N = 62$), so no paired statistical test of the gains was possible; a future study using matched respondents could apply an Independent Samples t-test to formalise what is here observed descriptively. U5 (Loading Speed) remained in Quadrant I despite a +1.248 gain because Firebase's cold-start latency has not been addressed; minimum instance configuration and edge caching are the logical next steps. U3 (Instruction Clarity) entered Quadrant I post-rebuild and now constitutes the primary engineering target for the next iteration. The overall framework WebQual 4.0 baseline, Derived IPA sequencing, iterative Prototyping, re-measurement does not require large teams or specialised infrastructure, which suggests it can be taken up directly by other Indonesian city administrations managing portals under the SPBE mandate of Presidential Regulation No. 95 of 2018.

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