Performance Assessment of Local Infrastructure in Banyumas Regency, Indonesia, Using a Cloud-Based IoT-GIS Monitoring Framework

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Abstract
Infrastructure performance in Banyumas Regency, Indonesia, is currently measured only through availability and quality, leaving utilization, appropriateness, local employment, and sustainability unobserved. This study measured infrastructure performance on seven indicators and developed a prototype monitoring framework. A cloud-based digital survey collected responses from 400 staff of 27 sub-district offices and six technical regional agencies between March and June 2026. Data were analyzed using importance–performance analysis, gap analysis, Potential Gain in Customer Value (PGCV) analysis, and composite-score ranking, and mapped by sub-district in a geographic information system. The composite performance score was 3.17 on a five-point scale, a moderate level. Sustainability (2.64) and job creation (2.89) performed lowest and had the largest gaps (−1.91 and −1.46), placing both in the priority quadrant; PGCV gave them the highest priority values (10.74 and 9.18). Ten sub-districts, led by Lumbir, Gumelar, and Somagede, were identified as priority areas. A prototype IoT-GIS dashboard was developed to support annual monitoring. Because respondents were government officials and the data cover one year, the results reflect official perceptions and require validation with residents.

Keywords: Banyumas; gap analysis; importance–performance analysis; infrastructure performance; IoT-GIS

I. INTRODUCTION

Infrastructure underpins economic activity and everyday welfare, and its provision has been framed as a foundation for sustainable development (Thacker et al., 2019). For local governments, the practical question is no longer only whether infrastructure exists, but how well it performs for the people and institutions that depend on it. Answering that question requires indicators that go beyond physical supply.

Conventional evaluation relies largely on engineering-based indicators, such as facility coverage and technical specifications, and on government performance assessments that track inputs and outputs. Zhou et al. (2025) observe that both approaches say little about user satisfaction and service quality from the demand side. Citizen satisfaction with urban services has also been analyzed in relation to citizens' expectations and the performance of those services (Van Ryzin, 2004). This is the logic behind comparing how important people consider an infrastructure attribute with how it actually performs, which is the basis of importance–performance analysis (IPA), introduced by Martilla and James (1977). In IPA, each attribute is placed in one of four quadrants according to its importance and performance, so that attributes that are important but perform poorly can be identified as priorities.

In Indonesia, this logic is applied through the Infrastructure Service Satisfaction Index (Indeks Kepuasan Layanan Infrastruktur, IKLI), which local governments use to measure public satisfaction with infrastructure services. Malang City's 2022 measurement, for

example, covered six indicators (physical availability, physical quality, appropriateness, utility, job creation, and contribution to the economy) and interpreted the results with IPA, gap analysis, and Potential Gain in Customer Value (PGCV) analysis (Kurniawan et al., 2023). Comparable index measurements have been reported for Serang Regency (Hakim et al., 2025) and for road development in two sub-districts of Jember Regency (Haliza et al., 2024), both of which measured community satisfaction.

Banyumas Regency in Central Java has a narrower measurement practice. According to its regional planning documents, infrastructure performance is currently measured through availability and quality only. At the regency target level, an infrastructure competitiveness index covers only transport infrastructure and electricity and water utilities. Satisfaction measurement for technical agencies focuses on administrative and licensing services rather than on built infrastructure. As a result, whether infrastructure matches needs, is used, supports local jobs and the local economy, or is environmentally sustainable is not routinely observed, and peripheral areas are poorly monitored.

Digital technology offers a way to monitor infrastructure more frequently. The Internet of Things (IoT), a network of connected devices that collect and transmit data, has been applied widely to structural health monitoring of buildings, bridges, and cultural heritage, where sensors send data to cloud-based storage for evaluation (Bhatta & Dang, 2024). Reviews of GIS–IoT integration describe how geospatial analysis and visualization complement real-time data collection (Bazargani et al., 2021). The applications described in these reviews are directed at the physical condition of individual structures and not at the performance of infrastructure services across a region as perceived by those who plan and use them.

Three gaps therefore remain at the local level. First, the IKLI measurements reviewed here, for example the six indicators used in Malang (Kurniawan et al., 2023), include no indicator of environmental sustainability. Second, in the studies reviewed we found no description of a cloud-connected data layer or a GIS dashboard that supports repeated monitoring by sub-district. Third, the IoT applications reviewed above concentrate on the physical condition of individual structures and not on the perceived performance of infrastructure services across a region.

This study addresses these gaps in the first year of a five-year research roadmap in Banyumas Regency. It combines a cloud-based digital survey designed as the data layer of an IoT-GIS monitoring system with seven performance indicators: availability, quality, appropriateness, utility, job creation, economic contribution, and sustainability. Sustainability is not among the six indicators used in the Malang measurement described above (Kurniawan et al., 2023). The respondents are staff of sub-district offices and technical regional agencies, so the results reflect the perceptions of local government officials and not those of the general public.

The objectives of this study are (1) to measure the performance of local infrastructure in Banyumas Regency on the seven indicators; (2) to identify priority indicators using importance–performance, gap, and PGCV analysis; (3) to identify priority sub-districts through composite-score ranking and spatial mapping; and (4) to present a prototype cloud-based IoT-GIS dashboard as the basis for annual monitoring, and to draw policy implications for the regency government. The remainder of the paper describes the method, presents the results, and discusses their implications and limitations.

II. METHOD

Research Design

This study employed a mixed-methods approach with a single-case design in Banyumas Regency, Central Java, Indonesia. The quantitative descriptive component measured the performance of local infrastructure on seven indicators and ranked sub-districts by

composite score. The qualitative exploratory component, consisting of field observation and focus group discussions (FGDs), was used to interpret the survey results and to formulate improvement strategies. The study constitutes the first year of a five-year research roadmap funded under the Institutional Research (RISIN) scheme of Universitas Jenderal Soedirman.

Study Area and Respondents

Banyumas Regency consists of 27 sub-districts and had an estimated population of 1,900,930 in 2025. The infrastructure examined covers basic-service facilities: roads and bridges, drinking water supply systems, educational facilities, health facilities, government buildings, and public green open space.

Respondents were staff of the 27 sub-district offices and of six technical regional agencies (public works, housing and settlement areas, environment, health, education, and regional planning). Sample size was determined using Slovin's formula, $n = N / (1 + Ne^2)$, with $N = 1{,}900{,}930$ and a margin of error of $e = 5\%$, which yields $n \approx 400$. The sample was spread across the 33 units with approximately equal allocation: 351 respondents from sub-district offices (about 13 per sub-district) and 49 from the agencies (about 8 per agency). Participation was by quota: the online form was distributed to all 33 units with a target of about 12 respondents per unit, and staff completed it voluntarily. The sample is therefore non-probabilistic, and Slovin's formula served only to set the overall target size. Because respondents were government officials and not a random sample of residents, the scores reported here represent the perceptions of local government officials rather than public satisfaction.

Data Collection

Primary data were collected through three techniques. First, a digital survey was distributed to all units between March and June 2026, and 400 responses were obtained, equal to 100% of the target. Second, field observations were carried out between April and June 2026 at infrastructure points identified as critical in the survey. Third, FGDs were held between June and July 2026 with technical agency staff and selected respondents to confirm the survey findings and identify policy options.

Secondary data were requested from the technical agencies between May and July 2026. They comprised technical documents and spatial data on road and bridge condition, drinking water service coverage, educational and health facilities, government buildings, and green open space. The instrument was developed in January–February 2026 and piloted in March 2026. Internal consistency of the seven performance items was assessed with Cronbach's alpha.

Performance Indicators

Infrastructure performance was assessed using seven indicators (Table 1). Respondents rated both the performance and the importance of each indicator on a five-point scale. Mean scores were interpreted as Low (below 2.75), Low–Moderate (2.75–2.99), Moderate (3.00–3.59), and Moderate–High (3.60–4.19).

Table 1. Indicators of infrastructure performance

No	Indicator	Description
1	Availability	Physical presence and coverage of infrastructure
2	Quality	Physical condition of existing infrastructure
3	Appropriateness	Fit between infrastructure and community needs
4	Utility	Extent to which infrastructure is used
5	Job creation	Absorption of local labor in infrastructure development
6	Economic contribution	Contribution of infrastructure to the local economy
7	Sustainability	Application of green building principles

Cloud-Based Survey and GIS Monitoring Framework

The digital form served as the data-ingestion layer of the proposed monitoring framework. Responses are stored automatically in the cloud, so the same instrument can be repeated each year to build a time series. Each response was linked to the sub-district boundary layer in a geographic information system (GIS) and displayed on a prototype dashboard. No physical sensors were deployed in the first year of the study; their integration is planned for the second year of the roadmap.

Data Analysis

Responses were verified and screened for outliers, and mean performance and importance scores were calculated for each indicator using spreadsheet and statistical software (Excel/SPSS).

Importance–performance analysis (IPA), following Martilla and James (1977), plotted mean importance (vertical axis) against mean performance (horizontal axis) for the seven indicators. The axes were crossed at the mean importance (3.85) and the mean performance (3.17), producing four quadrants: Quadrant I (concentrate here), Quadrant II (keep up the good work), Quadrant III (low priority), and Quadrant IV (possible overkill).

Gap analysis calculated the gap for each indicator as the mean performance score minus the mean importance score, with importance serving as the benchmark of expectation. Negative gaps indicate performance below expectation.

Potential Gain in Customer Value (PGCV), following Hom (1997, was used to rank the indicators by the improvement they would deliver. For each indicator, the achieved customer value was ACV = I × P, the ultimately desired customer value was UDCV = I × 5 (5 being the maximum of the scale), and PGCV = UDCV − ACV = I × (5 − P), where I and P are the mean importance and mean performance scores, following the procedure applied to infrastructure services by Kurniawan et al. (2023). A higher PGCV indicates a higher priority for improvement.

For spatial prioritization, the composite score of each sub-district was calculated as the unweighted mean of its seven indicator scores, and sub-districts were ranked from lowest to highest. Sub-district-level PGCV was not computed, because each sub-district was represented by only about 13 respondents, which would make indicator-level importance means unstable. Composite scores were mapped by sub-district in the GIS and compared with the secondary technical data to identify mismatches between technical conditions and perceptions.

III. RESULTS AND DISCUSSIONS

A. Result

Respondent Coverage

The survey reached all 400 targeted respondents, a 100% realization against the target. Of these, 351 respondents (87.75%) were staff of the 27 sub-district offices and 49 (12.25%) were staff of the six technical agencies.

Coverage of the predetermined quota should not be interpreted as a population response rate. The achieved 400 records constitute a complete return against the study target, rather than a probability sample of the approximately 1.9 million residents. The sample comprises 351 sub-district office staff (87.75%) and 49 technical-agency staff (12.25%). Respondent group composition and possible differences between technical agencies and local offices were not analyzed separately; consequently, the reported means describe the combined official respondent pool.

Performance of the Seven Indicators

The composite performance score across the seven indicators was 3.17 on a scale of 1 to 5, which falls in the moderate category (Table 2). Indicator scores ranged from 2.64 to 3.67. Utility (3.67) and availability (3.58) scored highest, whereas job creation (2.89) and sustainability (2.64) scored lowest. The mean importance rating across indicators was 3.85, so the mean gap between performance and importance was −0.68.

The coexistence of comparatively high ratings for utility (3.67) and availability (3.58) with low ratings for sustainability (2.64) and job creation (2.89) suggests that the existence and day-to-day use of facilities are not, by themselves, sufficient proxies for broader environmental and socioeconomic outcomes. This interpretation concerns ratings made by officials and cannot establish measured environmental impacts, contract employment, or actual service use by residents. The difference between the highest- and lowest-rated indicator is 1.03 points on the five-point scale.

Table 2. Performance, importance, gap, and IPA quadrant of the seven indicators (scale 1–5)

Indicator	Performance	Importance	Gap	Quadrant	Performance category
Availability	3.58	4.20	−0.62	II	Moderate
Quality	3.21	3.55	−0.34	IV	Moderate
Appropriateness	3.05	3.05	0.00	III	Moderate
Utility	3.67	4.05	−0.38	II	Moderate–High
Job creation	2.89	4.35	−1.46	I	Low–Moderate
Economic contribution	3.12	3.20	−0.08	III	Moderate
Sustainability	2.64	4.55	−1.91	I	Low
Mean	3.17	3.85	−0.68	–	Moderate

Notes: Gap = performance − importance. Quadrant cut-offs are the mean importance (3.85) and mean performance (3.17). I = concentrate here; II = keep up the good work; III = low priority; IV = possible overkill.

Importance–Performance Analysis

Figure 1 shows the position of the indicators in the IPA diagram. Sustainability and job creation fall in Quadrant I: both were rated highly important (4.55 and 4.35) but performed below the mean. Availability and utility fall in Quadrant II, above the mean on both axes. Appropriateness and economic contribution fall in Quadrant III, below the mean on both axes. Quality has an importance of 3.55, below the mean, and a performance of 3.21, only 0.04 above the mean, so it falls in Quadrant IV at the boundary with Quadrant III.

The quadrant placement adds policy context to the raw indicator averages: two dimensions of implementation outcomes (sustainability and local employment) appear in the high-importance/low-performance quadrant, whereas two basic service dimensions (availability and utility) appear above both grand means. Nevertheless, neither of the Quadrant II indicators meets its stated importance rating. The position of quality should also

be treated cautiously: its performance of 3.21 lies only 0.04 above the crosshair at 3.17, so modest shifts in the sample or reference line could change its quadrant.

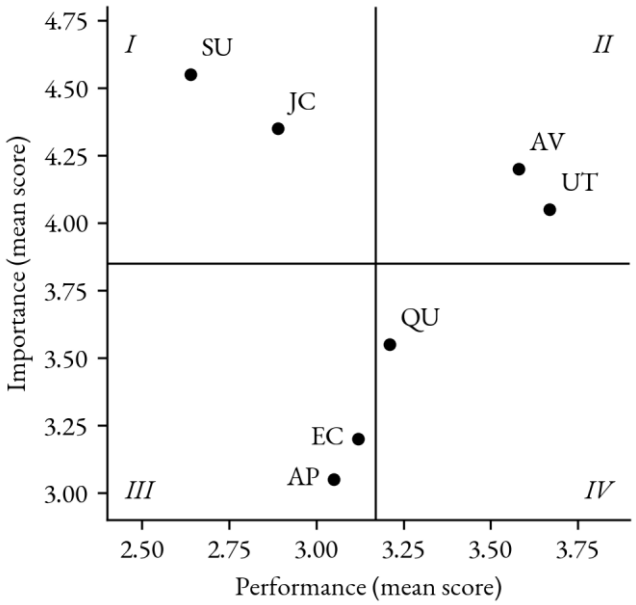

Figure 1. Importance–performance diagram of the seven indicators.

Notes: AV = availability; QU = quality; AP = appropriateness; UT = utility; JC = job creation; EC = economic contribution; SU = sustainability. Crosshair at the mean importance (3.85) and mean performance (3.17).

Gap Analysis

Six of the seven indicators had negative gaps (Table 2). Sustainability (−1.91) and job creation (−1.46) had the largest shortfalls; together they accounted for 3.37 of the 4.79 total absolute gap points, or 70.4% of the sum of indicator-level shortfalls. The remaining negative gaps were availability (−0.62), utility (−0.38), quality (−0.34), and economic contribution (−0.08). Appropriateness showed a zero gap at the reported precision. These gap shares are descriptive comparisons among the seven indicators, not estimates of the share of infrastructure projects or residents affected.

Potential Gain in Customer Value (PGCV)

PGCV values were highest for sustainability (10.74) and job creation (9.18), followed by quality (6.35), economic contribution (6.02), availability (5.96), appropriateness (5.95), and utility (5.39) (Table 3). The top two indicators are the same as those identified by importance–performance and gap analysis. Quality ranks third on PGCV although its gap is among the smaller ones, because PGCV weights the distance between performance and the scale maximum by importance, whereas the gap compares performance with importance.

The PGCV approach yields a somewhat different ordering for the middle indicators because it compares performance with the scale ceiling of five, rather than with reported importance. For example, quality ranks third in PGCV (6.35) despite a relatively small expectation gap of −0.34, while availability has a larger expectation gap (−0.62) but ranks fifth in PGCV (5.96). Therefore, PGCV should be used as a complementary improvement-potential measure rather than interpreted as a financial benefit estimate or a prediction of the effect of a specific project.

Table 3. Potential Gain in Customer Value (PGCV) of the seven indicators

Rank	Indicator	Importance (I)	Performance (P)	PGCV
1	Sustainability	4.55	2.64	10.74
2	Job creation	4.35	2.89	9.18
3	Quality	3.55	3.21	6.35
4	Economic contribution	3.20	3.12	6.02
5	Availability	4.20	3.58	5.96
6	Appropriateness	3.05	3.05	5.95
7	Utility	4.05	3.67	5.39

Notes: PGCV = UDCV − ACV = I × (5 − P), with ACV = I × P and UDCV = I × 5 (Hom, 1997). I and P are the mean importance and mean performance scores.

Priority Sub-districts

Ranking the 27 sub-districts by their unweighted composite scores identified ten with the lowest scores (Table 4, Figure 2). Lumbir scored 2.41, followed by Gumelar (2.53) and Somagede (2.58). The reported scores of all ten priority sub-districts were below the regency-wide composite score of 3.17, with Wangon scoring 2.92. Across the ten listed areas, the unweighted mean was 2.70 (derived from Table 4), or approximately 0.47 points below the regency reference. This comparison is descriptive only: the regency-wide mean includes the technical-agency respondents, while a sub-district score reflects its local respondents. The treatment-priority labels in Table 4 are planning categories, not statistically tested differences between sub-districts.

Table 4. Ten sub-districts with the lowest composite scores

Rank	Sub-district	Composite score	Treatment priority
1	Lumbir	2.41	Highest
2	Gumelar	2.53	High
3	Somagede	2.58	High
4	Tambak	2.62	High
5	Purwojati	2.67	High
6	Kebasen	2.74	Moderate–High
7	Kemranjen	2.79	Moderate–High
8	Pekuncen	2.83	Moderate–High
9	Cilongok	2.88	Moderate
10	Wangon	2.92	Moderate

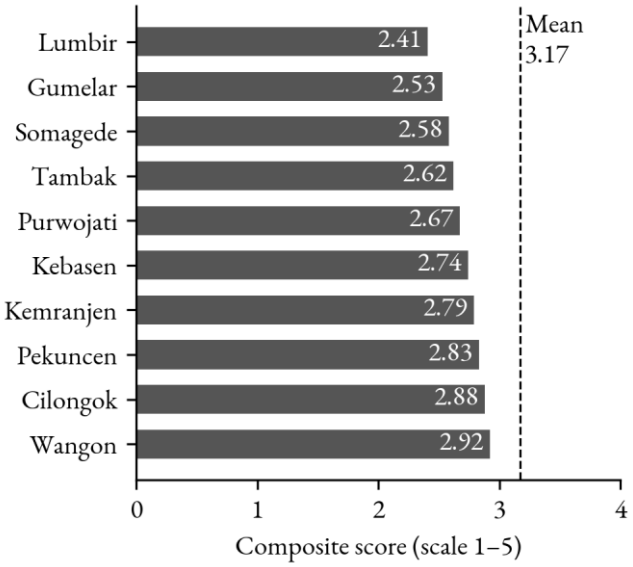

Figure 2. Composite scores of the ten priority sub-districts.

Secondary Data from Technical Agencies

Data from the technical agencies described the existing condition of infrastructure. Most district roads were in stable condition (good or fair), although some peripheral sections were lightly to heavily damaged. Drinking water coverage was uneven, with lower service levels in peripheral areas than in urban areas. Some schools and health centers needed maintenance or renovation, and green open space and public parks were not evenly available across sub-districts. Performance indicators in the regional planning documents covered only availability and quality.

Comparing these data with the survey scores revealed mismatches between technical condition and perception: some areas with technically sufficient infrastructure were still scored low by respondents. Because the secondary data were qualitative summaries by agency, this pattern is exploratory and could not be tested numerically.

Prototype Monitoring Dashboard

The prototype dashboard displays cloud-submitted survey records against sub-district boundaries (Figure 3). It supports filtering and a consistent geographic display of indicator and composite results and was internally tested by the research team. The architecture allows future survey rounds to be compared, but only the 2026 survey is available at this stage. The dashboard does not currently ingest physical sensor measurements; consequently, it demonstrates digital survey-based GIS monitoring rather than real-time sensing of infrastructure conditions.

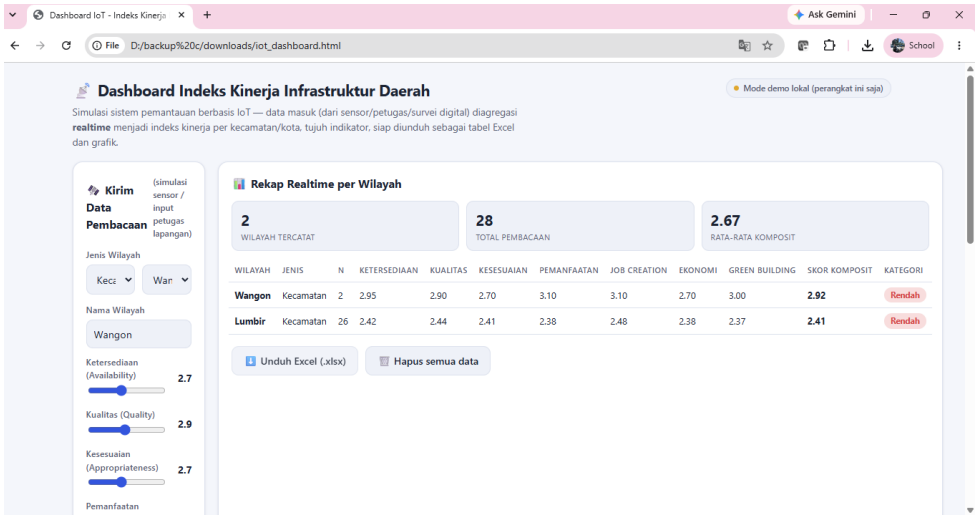

Figure 3. Prototype IoT-GIS monitoring dashboard.

Cross-Method Diagnostic Synthesis

A comparison of the three prioritization methods strengthens the interpretation of the principal findings. Sustainability and job creation occupy IPA Quadrant I, have the two greatest negative expectation gaps, and rank first and second on PGCV. This convergence is more persuasive for screening priorities than the result of any single method. Table 5 quantifies how much each indicator contributes to the sum of absolute expectation gaps. The percentages are calculated from the published rounded gap scores; they do not describe causal contributions to low performance or prescribe proportional budget allocations.

Table 5. Derived gap-share diagnostics and PGCV priority for the seven indicators

Indicator	Gap (P − I)	Share of absolute gaps	PGCV rank
Sustainability	-1.91	39.9%	1
Job creation	-1.46	30.5%	2
Availability	-0.62	12.9%	5
Utility	-0.38	7.9%	7
Quality	-0.34	7.1%	3
Economic contribution	-0.08	1.7%	4
Appropriateness	0.00	0.0%	6

Notes: Gap shares = |individual gap| / Σ|gap| × 100 across seven indicators. The absolute-gap total is 4.79 points; values are rounded. Derived from the original Table 2; PGCV ranks from Table 3.

Sustainability contributes 39.9% and job creation 30.5% of the seven-indicator absolute-gap total, or 70.4% together. By contrast, appropriateness contributes 0.0% because its two reported means coincide. The dominance of the first two gaps does not establish that they occur in the same sub-districts, since sub-district-level indicator gaps were not reported. Figure 4 juxtaposes the expectation-gap magnitudes and PGCV values on separate scales, making the consistency in the top two positions visible without treating unlike metrics as interchangeable.

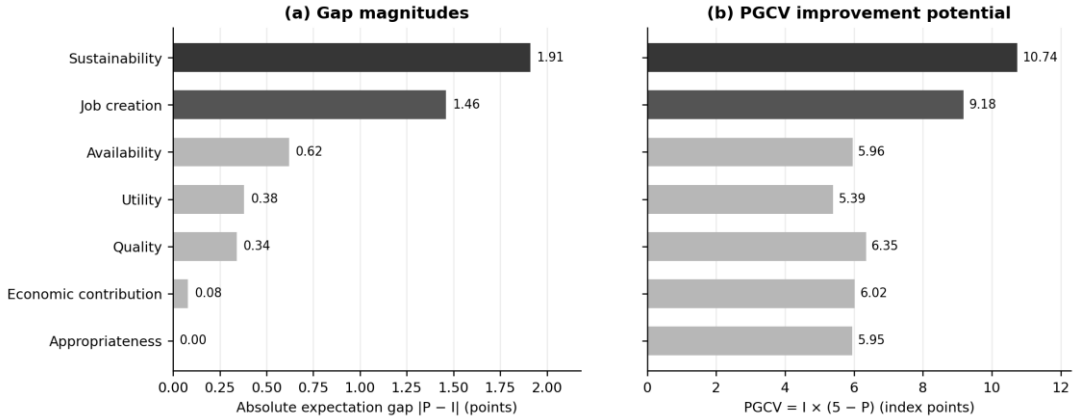

Figure 4. Comparison of absolute expectation gaps and PGCV values by performance indicator.

Notes: The two panels use different units and scales. Dark bars denote the two indicators consistently ranked first and second. Values reproduce Tables 2 and 3 or are directly derived from them.

B. Discussion

Overall Performance of Local Infrastructure

The composite score of 3.17 indicates that, in the view of the officials surveyed, infrastructure in Banyumas performs at a moderate level and falls short of expectations on six of the seven indicators. Comparable measurements exist under the Indonesian infrastructure service satisfaction index (IKLI) framework. Malang City's 2022 measurement, for example, applied importance–performance analysis, gap analysis, and PGCV analysis to six indicators: physical availability, physical quality, appropriateness, utility, job creation, and contribution to the economy (Kurniawan et al., 2023). The present study uses a similar analytical toolkit with seven indicators, adding sustainability, but its respondents are officials, whereas the Malang measurement reported residents' satisfaction. Because IKLI studies differ in scale, instruments, and respondents, we compare analytical approaches rather than index values.

Interpreting the seven dimensions jointly changes the policy reading of a moderate composite score. An average of 3.17 is not evidence that each domain performs moderately: the 1.03-point spread from sustainability to utility indicates material heterogeneity. A single average can therefore conceal low performance in dimensions that officials consider strategically important. Routine reporting should publish both the aggregate and its seven components, including importance ratings and uncertainty arising from the sampling design. Neither the composite nor its component scores should be described as independently verified physical-condition measurements.

Sustainability and Local Job Creation as Priorities

Sustainability and job creation showed the largest gaps (−1.91 and −1.46) and both fell in Quadrant I. A plausible reading is that infrastructure planning in Banyumas has given limited explicit attention to environmental performance and local labor, even though respondents rated both as highly important. The data cannot confirm this explanation, because no information on project design or procurement was collected.

The priority assignment is supported by methodological triangulation rather than by statistical inference. IPA identifies the strategic mismatch between importance and performance; gap analysis provides its direction and magnitude; and PGCV considers distance from the maximum score. Agreement on the leading two indicators across these methods reduces sensitivity to a single ranking convention. Nonetheless, they use the same survey responses, so their agreement is not independent validation. Without item-level

distributions, confidence intervals, or a robustness test using different quadrant crosshairs, the stability of the findings cannot be quantified.

For sustainability, formal rating systems such as Envision, BREEAM Infrastructure, and Infrastructure Sustainability have been developed to evaluate sustainable approaches in infrastructure projects (Milić & Bleiziffer, 2024). A comparison of three transportation rating systems found that they assess and reward sustainability practices differently (Oluwalaiye & Ozbek, 2019). Our indicator is perception-based and is not equivalent to any certified rating, so aligning its definition with an established framework is a sensible next step.

The sustainability item in this study specifically refers to the application of green building principles (Table 1). This is a narrower construct than environmental sustainability across a heterogeneous infrastructure portfolio comprising roads, bridges, water systems, schools, health facilities, and green space. It would be premature to interpret its low score as measured deficiencies in emissions, biodiversity, energy efficiency, or infrastructure resilience. Future rounds could define asset-specific, verifiable measures such as life-cycle maintenance, energy and water efficiency, ecological mitigation, and climate-risk screening, while retaining the original perception item for longitudinal comparability.

For job creation, the evidence from other settings is mixed. Highway funding under the American Recovery and Reinvestment Act raised construction payrolls at the county level, but no clear effect on aggregate local employment could be detected (Garin, 2019). A labour-intensive road programme in Limpopo, South Africa, met its targets for jobs created and road length, while its effects on poverty and sustainable livelihoods were mixed (Musekene, 2013). These results suggest that local labor absorption is unlikely to occur as a by-product of construction and needs to be specified as an explicit target, for instance in procurement.

For local employment, a more operational monitoring approach would distinguish temporary construction jobs from longer-term local economic opportunities. Candidate project-level metrics include local worker-days, the share of project wages paid to residents, skills-training completions, and supplier participation. These are proposed validation measures rather than data observed in 2026. Care would also be needed to distinguish employment quantity from job quality and to avoid assuming that all infrastructure types have similar labor intensity. The implication is not that every project should maximize headcount, but that local employment objectives should be explicit where appropriate and monitored alongside technical performance.

Spatial Priorities and the Perception–Technical Mismatch

All ten priority sub-districts scored between 2.41 and 2.92, below the regency-wide composite of 3.17. The research team characterizes most of them as peripheral areas of the regency. Satisfaction with public services in rural and urban areas has been compared in a multi-group analysis (Ochoa-Rico et al., 2024), and infrastructure inequality has been described as a characteristic of urbanization (Pandey et al., 2022). Our pattern would be consistent with this general picture if the peripheral location of these sub-districts is confirmed with distance or accessibility data, which this study did not collect.

Comparing secondary data with survey scores showed that some areas with technically sufficient infrastructure were still rated low. This mismatch may reflect weaker utilization and appropriateness in those areas. Whatever its cause, it shows that the availability and quality indicators now used in regional planning documents would not flag these areas. Because the secondary data were qualitative summaries by agency, the pattern is exploratory, and a numerical comparison by sub-district is a task for the next survey round.

Spatial ranking is most useful as a first-stage screening tool. The ten lowest sub-district scores identify where a follow-up audit may yield useful information, but the ranking does not reveal which specific facility, indicator, or community is underserved in each area. Nor does it establish that physical remoteness causes low scores: no standardized travel time, terrain, cost, or accessibility measure was included in the comparison. Before capital funds

are allocated, the dashboard results should be joined to verified infrastructure inventory data, asset condition records, population served, and planned maintenance works. Such triangulation would permit the government to distinguish access gaps from service-quality and management problems.

Reading the Importance–Performance Results with Care

Three points qualify the quadrant results. First, the quadrant boundaries are relative, because they are set at the means. Quadrant II therefore means "above average" and not "no gap": availability and utility still had negative gaps of −0.62 and −0.38. Quality lies only 0.04 above the mean performance and sits at the boundary between Quadrants III and IV, so it should not be read as a distinct finding.

Second, importance was self-reported alongside performance. Zhou et al. (2025) point out that collecting both increases subjectivity and respondent burden, and they instead derived importance statistically from partial correlations with overall satisfaction, using 1,397 valid responses from small towns in Wuhan, China. The conceptual assumptions of importance–performance analysis have also been critically reviewed (Oh, 2001). Because our respondents were officials, high importance ratings for sustainability and job creation may partly reflect policy priorities rather than experienced need. A derived-importance approach could be tested in the next survey round.

Third, the Wuhan study identified road and transport and townscape and character as its main high-importance, low-satisfaction domains (Zhou et al., 2025), whereas in Banyumas these were sustainability and job creation. The two studies used different indicator sets and respondents, so the difference is not directly comparable.

PGCV ranked sustainability and job creation first and second, in agreement with importance–performance and gap analysis, but ranked quality third, ahead of availability, which the gap analysis ranked third. This is expected, because PGCV measures the distance between performance and the scale maximum weighted by importance (Kurniawan et al., 2023), whereas the gap compares performance with importance. The two measures therefore agree on the main priorities and can differ on the order of the rest.

A practical consequence of the nonidentical rankings is that the first two indicators warrant immediate diagnostic attention, while the relative positions of quality, availability, and the other middle-ranked indicators should be interpreted with caution. An intervention scoring matrix could combine observed urgency, risk, service population, engineering condition, equity, cost, and project readiness. The survey-based PGCV score alone cannot estimate a cost-benefit ratio or replace engineering safety requirements. In particular, any critically unsafe road, bridge, or public building would require an asset-specific assessment even where its corresponding survey dimension does not rank first.

From Survey to Monitoring Framework

The prototype dashboard is the practical contribution of this first year. Reviews describe the integration of GIS and IoT as combining real-time data collection with spatial visualization and analysis (Bazargani et al., 2021), and a review of smart governance identifies cloud-based data infrastructures and geospatial platforms as key technology areas (Sofianopoulos et al., 2025). Our prototype realizes only part of this picture: cloud-based data intake mapped by sub-district and repeatable each year, without physical sensors. It is therefore better described as a foundation for monitoring than as real-time infrastructure monitoring, and sensor integration remains work for the second year.

For institutional adoption, the monitoring framework requires more than a visualization interface. Annual questionnaires need fixed item definitions and a stable reference period; incoming records need timestamps, geographic identifiers, duplicate checks, and an audit trail; and permissions should separate data entry, validation, and publication. A dashboard should indicate the number of respondents behind each displayed mean and suppress overly

granular comparisons when cell counts are small. Sensor data envisaged for subsequent years must be time-aligned and geographically linked to asset IDs rather than treated as interchangeable with subjective ratings. Until these components are implemented and externally evaluated, the system should be presented as a tested prototype of cloud-based survey–GIS integration, not a validated live IoT sensing network.

Policy Implications and Limitations

The findings support a staged policy response rather than an automatic redistribution of capital budgets. First, Banyumas could expand the current availability-and-quality reporting model to include all seven dimensions, with clearly defined survey items and physical indicators appropriate to each asset class. Second, sustainability and local job creation deserve targeted diagnostic audits because all three prioritization methods agree on their importance-performance deficits. Third, the ten low-scoring sub-districts offer a geographic starting point for field verification and participatory assessment, not a definitive investment ranking. Fourth, annually repeated measurements can be used to test whether approved interventions are followed by improvement, provided item wording, sample groups, and geographic coverage remain comparable. Table 6 translates the present evidence into possible actions and measures of verification; none of these actions was tested for effectiveness in the present study.

Table 6. Evidence-informed policy actions and proposed verification measures

Observed evidence	Proposed management response	Verification metric (future data)
Sustainability: P=2.64; I=4.55; PGCV=10.74	Audit environmental design and maintenance practices by asset class; specify realistic environmental requirements in projects.	Compliance against asset-specific criteria; audited energy/water use and maintenance records.
Job creation: P=2.89; I=4.35; PGCV=9.18	Track local workforce participation where procurement and labor regulations permit; distinguish short-term and ongoing jobs.	Local worker-days; verified local wage expenditure; training/contract records.
Ten sub-districts: composite 2.41–2.92	Use scores to select areas for joint community and technical field reviews before final investment decisions.	Resident surveys; asset-condition checks; service access and population served.
Data mismatch: perception vs. technical summaries	Link asset inventory and technical records to the dashboard using consistent identifiers and dates.	Completeness of geocoded assets; agreement and explained divergence between measures.
Single-year cloud survey prototype	Set an annual measurement protocol and pilot selected sensor feeds only after data governance is established.	Reproducible annual series; dashboard usability tests; sensor validation and error logs.

Notes: Proposed management responses and verification metrics are recommendations derived from the findings, not implemented or evaluated interventions. All 2026 survey quantities are taken from Tables 2–4.

Implementation could begin with a low-cost validation round in Lumbir, Gumelar, and Somagede, accompanied by a small set of comparison sub-districts. Within each location, resident interviews and accessible asset inspections could establish whether a low composite score stems from inadequate access, poor condition, mismatched use, limited local employment, or perceived environmental performance. Project prioritization would then integrate the survey signal with legal service standards and safety risks. This design would provide stronger evidence for resource allocation than treating a composite score as a direct proxy for engineering need.

The findings are subject to important design and measurement limitations. First, all 400 responses came from government officials recruited through voluntary quota allocation; they represent the respondents' perceptions, not an independently representative sample of residents. The population figure used with Slovin's formula set a nominal target size but does not justify a probability-based margin of sampling error for this sampling design. Second, approximately 13 office respondents per sub-district limit the stability of local rankings, and comparisons with the overall composite are descriptive because the latter also includes technical-agency responses. Third, no respondent-level variance estimates, confidence intervals, test–retest statistics, or Cronbach's alpha coefficient are reported in the paper; reliability and ranking uncertainty therefore cannot be independently assessed. Fourth, the unweighted composite assumes equal value across all seven indicators, while self-reported importance and performance may share response biases. Fifth, the research covers only one year, meaning no trends or policy effects can be inferred. Sixth, secondary technical information was summarized qualitatively rather than linked in matched numerical records to each survey area; the suggested perception–technical mismatch is therefore exploratory. Seventh, the green-building wording of the sustainability item restricts its reach across infrastructure types, and the job-creation item does not measure verified employment. Finally, the IoT-GIS architecture has been internally tested as a cloud survey–GIS prototype without sensor deployment, independent usability assessment, or operational reliability evaluation.

The next research phase should address these limitations in a prespecified validation design: recruit residents using a documented sampling frame, preserve an official-response subgroup for continuity, report dispersion and internal consistency for the scale, and test sensitivity of district rankings to weights and respondent composition. Linking time-stamped technical indicators to survey records by sub-district and asset class would allow the hypothesized mismatch to be evaluated quantitatively. A repeated measurement after documented interventions, with matched indicators and data quality checks, would help determine whether scores change over time, although causal attribution would still require a stronger comparative design. These improvements are especially important before the framework is used to support binding budget decisions.

IV. CONCLUSION

Using a cloud-based digital survey completed by 400 officials from 27 sub-district offices and six technical agencies, this study assessed seven dimensions of local infrastructure performance in Banyumas Regency. The overall composite was 3.17/5 (moderate), but the indicator-level range of 2.64–3.67 shows why the mean should not be used alone. Sustainability and local job creation were consistently identified as priorities by IPA, expectation-gap analysis, and PGCV: their gaps were −1.91 and −1.46 and their PGCV values were 10.74 and 9.18. Together they accounted for 70.4% of the sum of the seven absolute expectation gaps, an indicator-level descriptive result rather than an allocation rule. Ten sub-districts scored between 2.41 and 2.92, led by Lumbir, Gumelar, and Somagede as priority areas for follow-up verification. The cloud survey–GIS prototype offers a repeatable foundation for spatially structured monitoring, although no physical sensors are yet deployed. Policy use should therefore combine these official perceptions with resident feedback and verified technical data, and should test indicator reliability, district-ranking sensitivity, and subsequent changes in repeated survey rounds.

ACKNOWLEDGEMENT

The authors thank Universitas Jenderal Soedirman, through the Institute for Research and Community Service (LPPM), for funding this research under the Institutional Research (RISIN) scheme in 2026, and the Faculty of Engineering for administrative support. The authors also thank the Regional Government of Banyumas Regency, especially the agencies

responsible for public works, housing and settlement areas, environment, health, education, and regional planning (Bappeda), for providing secondary data and taking part in the focus group discussions, and the respondents in the 27 sub-districts for completing the survey.

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