The ACES Circularity Index™

A place-based framework for measuring community-scale circular economy outcomes in distressed urban contexts

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ABSTRACT

Existing circular economy indicators — the Ellen MacArthur Foundation's Material Circularity Indicator, Circulytics, the EU Resource Efficiency Scoreboard — are designed for corporate supply chains with controlled material flows and defined product lifecycles. They poorly capture the dynamics of place-based circular interventions in low-income communities, where the social and economic value of recovery is often more important than the volume of material throughput, and where informal-economy participation makes top-down material accounting unreliable. The ACES Circularity Index™ (ACI) is a composite index measuring community-scale circular economy outcomes across five dimensions: Material Diversion, Value Recovery, Livelihood Generation, Local Economic Recirculation, and Behavioural Embedment. This paper sets out the conceptual basis, the dimension definitions, the scoring approach, the weighting rationale, the validation methodology, and acknowledged limitations of the index, drawing on early fieldwork in the Adikpo ACES™ programme, Benue State, Nigeria.

I. Background: why corporate circularity metrics fail at community scale

The circular economy literature of the last decade has produced an impressive set of measurement frameworks. The Ellen MacArthur Foundation's Material Circularity Indicator (MCI), introduced in 2015, scores a product or company on the proportion of its material flow that is restorative or regenerative.[1] Circulytics extended this with a corporate maturity model. The European Union's Resource Efficiency Scoreboard tracks national-level material productivity. These frameworks share three assumptions that do not hold in our operating context.

First, they assume **controlled material flows**: a closed manufacturing supply chain, with known inputs, known outputs, and known losses. In Adikpo — and in the great majority of African urban contexts — the waste stream is mixed, informal, and unmeasured. The "raw material" of the circular intervention is whatever the community generates, mostly unsorted, mostly uncatalogued.

Second, they assume **product-centric value**: circularity is good because it preserves the embodied value of a product. In a place-based context, the value that matters most is rarely the material itself. It is the wage paid to the resource steward who collected it, the food bought with that wage, the schoolbook the child opened the next morning. A framework that scores Adikpo on tonnes diverted but ignores the ₦ earned by the household that diverted them is measuring the wrong thing.[2]

> *A framework that scores a community on tonnes diverted but ignores the wage earned by the household that diverted them is measuring the wrong thing.*

Third, they assume **behavioural compliance is a given**: an industrial process recycles because the engineer designs it to. A household recycles because somebody asked it to, today — and may stop tomorrow. Sustained behavioural change is not a by-product of circular intervention in community contexts; it is the principal outcome.

The literature does acknowledge these gaps. Kirchherr, Reike and Hekkert's much-cited review found that of 114 published circular economy definitions, only a small minority gave equal weight to social and ecological dimensions.[3] Geng and Doberstein's earlier work on China explicitly called for context-sensitive indicators at municipal and community scales.[4] What is largely absent from the published literature is a worked

composite index suitable for the place-based, low-income, informal-economy context in which most of the world's regenerative work needs to happen. The ACES Circularity Index™ is our contribution to that gap.

II. The five dimensions

The Index is constructed from five dimensions, each normalised to a 0–100 scale and combined into a composite score. The dimensions are deliberately separable: any of them can be reported individually as a programme metric, and a composite ACI score should always be accompanied by the five constituent scores so that strengths and weaknesses are visible. We are explicit that this is a composite indicator and inherits all of the well-known limitations of composite indicators discussed in the OECD/JRC handbook.[5]

Material Diversion (MD)

The proportion of the catchment's waste stream that is diverted from landfill, open burning, or unmanaged dumping. Measured via depot weighbridge data triangulated against estimated household generation rates derived from periodic sampling. Score range 0–100, scaled linearly against a stretch target of 70% diversion (set with reference to the upper quartile of municipal recycling rates achieved in low-income country contexts).

Value Recovery (VR)

The economic value recovered per tonne of material handled, expressed in ₦, normalised against a context-specific benchmark. The benchmark is set per material category (plastics, metals, paper, organics) and updated quarterly using the depot's actual sale prices to local off-takers. Score 0–100 against a stretch target of 100% of context benchmark.

Livelihood Generation (LG)

The proportion of registered programme participants who reach or exceed the *Resource Steward* income threshold — the lowest of the five participant scorecard tiers — in any given month. Measured directly from the operational dashboard. Score 0–100, calibrated linearly.

Local Economic Recirculation (LER)

The proportion of programme expenditure (wages, off-take payments, supplier purchases) that is retained within a 50 km radius of the depot. Measured from finance ledger metadata. We follow the logic of local multiplier analysis in development economics[6] in privileging this dimension — capital that leaves the catchment within one transaction cycle does very different work to capital that stays.

Behavioural Embedment (BE)

The proportion of participating households that sustain a measurable circular practice (sorted source separation, regular drop-off, or composting) for six months or more after first engagement. Measured via paired household visits at month 1 and month 7. This dimension is the slowest to measure and the most diagnostic of long-term impact.

III. Scoring methodology

The composite Index is the weighted mean of the five dimensions, each normalised to a 0–100 score. The default formulation uses equal weights.

COMPOSITE INDEX

$$ACI = w_1 \cdot MD + w_2 \cdot VR + w_3 \cdot LG + w_4 \cdot LER + w_5 \cdot BE$$

where each dimension score is normalised to the interval [0, 100], and the default weight vector is $w = (0.20, 0.20, 0.20, 0.20, 0.20)$. The composite score is reported alongside the five constituent scores; it is never the sole reported figure.

Each dimension is computed monthly from the relevant data source. The Index is reported quarterly to align with funder reporting cycles, with the quarterly figure computed as the simple mean of the three monthly figures rather than a quarter-end snapshot — this damps month-to-month operational volatility and gives a more representative view of programme performance.

Data sources, frequency and provenance for each dimension are summarised below.

DIMENSION	PRIMARY SOURCE	FREQUENCY	LAG
Material Diversion	Depot weighbridge logs; household sampling	Monthly	~14 days
Value Recovery	Depot sale ledger; off-take pricing	Monthly	~7 days
Livelihood Generation	Participant income logs (operational dashboard)	Monthly	~3 days
Local Economic Recirculation	Finance ledger with supplier postcoded metadata	Monthly	~14 days
Behavioural Embedment	Paired household visits at m1 and m7	Rolling cohort	~7 months

IV. Weighting rationale

The default equal-weighting decision is deliberate and defensible, and follows the OECD/JRC handbook's guidance for composite indicators where empirical evidence for differential importance is not yet established.[5] Saisana and Tarantola's foundational review of composite indicator methodology argues that "equal weighting may often be a desirable choice because it implies that the indicators are of equal importance in absence of an explicit statistical or theoretical basis for differential weighting."[7]

The five dimensions of the ACI are conceptually distinct — not different views on the same underlying phenomenon — and we have, at the time of this paper, no empirical basis to claim that one dimension is more important than another for predicting long-term programme success. We expect this to change as data accumulates.

We anticipate three scenarios in which deviation from equal weighting will be justified:

- **Programme-stage weighting** — in the first 12 months of a new zone, Behavioural Embedment cannot meaningfully be measured (the 6-month lag means no data exists). A weighting of $w = (0.25, 0.25, 0.25, 0.25, 0.00)$ may be temporarily appropriate, with explicit disclosure that BE is excluded.
- **Funder-mandated weighting** — some funders weight livelihood and recirculation outcomes above material outcomes for explicit reasons of

mission alignment. We will report the funder-weighted composite as a secondary figure where requested, alongside the default ACI.

- **Empirically-derived weighting** — if longitudinal data accumulates that demonstrates one dimension is predictive of long-term programme success in ways the others are not, we will revisit the weighting in a published v2.0 of this paper, with clear disclosure of the prior decision.

V. Validation approach

Composite indicators are vulnerable to two distinct failure modes: *construct validity* failure (the index does not in fact measure what it claims to measure) and *reliability* failure (the index produces inconsistent results under nominally identical conditions). Our validation strategy addresses both.

Triangulation

Each dimension is computed from at least two independent data sources where feasible. Material Diversion combines depot weighbridge data with periodic household sampling; the two should track within an acceptable variance band, and a widening gap is treated as a data-quality signal not a programme signal. Local Economic Recirculation combines finance ledger metadata with periodic in-person verification of supplier locations.

Test-retest reliability

For the household-sampled and survey-derived components (MD sampling, BE assessment), we retain 10% of households for blind re-assessment by a different field officer within 14 days of the primary assessment. We target a Cohen's κ of 0.70 or above as the acceptable threshold; results below this are treated as a signal that the instrument needs revision.

Stakeholder validation panel

Each quarterly ACI report is reviewed by a panel comprising the Foundation's Executive Director, the Adikpo programme manager, two participant representatives drawn from the active resource steward cohort, and one external reviewer drawn from the Foundation's Independent Assurance roster. The panel's role is not to alter the score — the score is what the data says — but to flag where the score and the lived programme experience diverge. Persistent divergence is a signal that an indicator is failing.

VI. Illustrative findings from Adikpo

The Adikpo ACES™ programme began operational data collection in its inaugural phase in early 2026, following the Foundation's registration in February 2026. As of the writing of this paper, only a baseline-establishment phase has been completed; we do not yet report a published ACI figure for Adikpo, and we will not do so until at least four months of stable data collection have been completed across all five dimensions. This is a deliberate caution: a single early figure published from a programme still in its first operational quarter would mislead readers about the maturity of the underlying data.

What we can report from the baseline phase:

- Material Diversion baseline: estimated at **under 5%** across the Adikpo catchment prior to programme commencement, based on household sampling. Open burning remained the dominant disposal route.
- Value Recovery infrastructure: the depot's first off-take agreements were established in the baseline phase, allowing per-tonne benchmark prices to be set for four material categories.
- Livelihood Generation: within the inaugural phase the participant register has grown to more than one hundred households, a minority of whom have already reached the *Resource Steward* income threshold in at least one month. We do not report the precise proportion in this paper as the operational data is not yet stable enough for publication.
- Local Economic Recirculation: the programme's expenditure structure during the baseline phase reflected significant outside-catchment procurement (depot construction, weighbridge equipment) which is not representative of the steady-state. LER will be a more meaningful indicator from the second operational quarter forward.
- Behavioural Embedment: the first six-month cohort follow-up was not yet possible at the time of this paper. Initial findings will be reported in version 1.1.

The first full quarterly ACI for Adikpo will be reported in the Foundation's Q2 2026 impact statement, with all five dimensions explicit and the data provenance documented.

VII. Limitations and open questions

We are explicit about the limitations of this framework. A methodology paper that does not declare its weaknesses invites the reader to discover them, which is worse than declaring them.

Single-context development. The Index has been developed against a single operating context (Adikpo, Benue State, Nigeria). Some dimensions — particularly the Material Diversion stretch target and the Local Economic Recirculation 50 km radius — are calibrated to this context. Application in markedly different contexts (peri-urban, coastal, post-conflict) will require recalibration. We do not yet have empirical work supporting the cross-context portability of the calibration choices.

Self-report bias in Behavioural Embedment. Sustained behaviour change is self-reported during paired visits. We mitigate this through a small set of observable proxies (presence of separation containers, evidence of recent drop-off) but acknowledge that self-report bias is likely to inflate the BE score by an unknown margin.

Counterfactual. The Index reports what is, not what would have been without the programme. A community might show improving MD scores in the absence of any intervention due to background trends (municipal investment, generational change, market conditions). We are evaluating whether a paired comparison community design is feasible within the Foundation's budget envelope; the literature on community-level counterfactual design is mixed and the methodological burden is substantial.[8]

The composite-versus-dashboard question. Some readers will object that any composite indicator obscures more than it reveals, and that the five dimensions should always be reported separately. We have sympathy for this view and have committed to always publishing the five constituent scores. The composite remains useful as a single-number summary for funders who require one, and as a tracking variable for the programme itself, but it is not the only number we report.

We invite review, critique, and replication of this methodology. Comments and proposed revisions may be sent to the corresponding author at the address below.

HOW TO CITE THIS WORK

SUGGESTED · AUTHOR–DATE

Acka'a, M. (2026). *The ACES Circularity Index™: A place-based framework for measuring community-scale circular economy outcomes* (Methodology Paper v1.0). The Acka'a-Hitchman Foundation. https://vheritage.online/methodology/circularity-index.html

SUGGESTED · FOOTNOTE

Mariyah Acka'a, *The ACES Circularity Index™*, Acka'a-Hitchman Foundation Methodology Paper No. 1 (v1.0, 27 February 2026), https://vheritage.online/methodology/circularity-index.html.

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