Partner Q&A - Equilibrium & Convergence Model

Status key: **Considered** = covered in v2; **Partially** = addressed but needs small follow-up; **Needs answer** = gap we should fill; **Will be considered in the equilibrium draft** = reserved for the forthcoming Equilibrium Annex.

Comments - status

- **Considered:** Model should be scalable/adaptable regardless of data availability.
- **Considered:** Design theoretical model under ideal data; adapt to site constraints.
- **Partially:** Ontology to model interdependencies and governing variables.
- **Partially:** Ontology should formalise interdependencies and ground variables.
- **Considered:** Changing urban structure updates the ontology/state.
- **Considered:** Efficiency assumes homogeneous distribution across modes - may be problematic.
- **Partially:** Add upper overlapping layer as enabler based on data availability.
- **Considered:** System should work with 20%–100% data.
- **Considered:** Distinguish soft vs hard changes.
- **Considered:** Changing reference points makes gains hard to quantify.
- **Considered:** Methodology explores rerouting and uses underused capacity.
- **Considered:** Traffic (short-term) vs transport (long-term) distinction.
- **Considered:** Distinguish event impacts (D_eff) from system impacts (S).
- **Considered:** Include social indicators and user behaviour in the core model.
- **Considered:** Users optimise based on personal strategies (choice theory).
- **Partially:** All sub-indicators need +1–2% to ensure true equilibrium (not transition).
- **Partially:** Incorporate social baselines from Liser.
- **Partially:** Use baselines to estimate expected behaviour after disruptions.
- **Considered:** This affects compliance and reaction speed.
- **Considered:** Relaxation equation $\dot{E} = -\kappa(E - \bar{E}(x))$ derived from control/dynamical systems; $\bar{E}(x)$ from literature indicators.
- **Considered:** AF>1.1 is a project choice threshold; can be calibrated per city.
- **Considered:** C(t) evolution under disruption; topology constrains, flows determine.
- **Considered:** P(t) ridership weights are weekly/monthly; daily index uses latest weights; AFC >90%.
- **Considered:** EV-grid availability varies; SCADA sites real-time, others proxies/assumptions.
- **Considered:** SCADA definition: systems, metrics, and fallbacks (binary/averages).

- **Considered:** I(t) synergy defined across modes via distance/transfer/payment integration.
- **Considered:** High entropy is not necessarily chaos; joint check with performance E.
- **Considered:** Sensitivity indices (First/Total-order) computation approach.
- **Considered:** Spread vs concentrate flows under disruption and link to C.
- **Considered:** Maximum entropy must be recomputed when topology changes (C_normalized).
- **Considered:** Composite of uptime × spare capacity for EV charging indicator.
- **Partially:** D_eff includes exponential recency, entropy boost, and congestion nonlinearity.
- **Considered:** Unified D_eff equation applies to all disturbance types with calibrated weights.
- **Considered:** Action–effect mapping (e.g., pop-up bus lanes ↑R, smart pricing ↑P).
- **Considered:** Network fundamentally changed ⇒ treat as structural change.
- **Considered:** Variable AF threshold as function of baseline performance (α, β formulation).

Comments – For Equilibrium (Will be considered)

- Equilibrium is dynamic and can evolve with learning/adaptation.
- Homeostasis/athletic training analogy for shifting equilibrium markers.
- Equilibrium as theoretical set point with a priori assumptions.
- Scalable theoretical model for managing urban equilibrium with mobility focus.
- Equilibrium is context-dependent across cities.
- Equilibrium is static; evolving equilibrium implies recalibration.
- Traffic example: city remains the same while delays drop 20%.
- Support a dynamic version of equilibrium to capture learning.
- Equilibrium shifts with permanent (long-lived) changes.

Questions - short answers

1. **Do we consider citizen behaviour?**

Yes - B(t) and P(t) capture compliance, willingness, and pricing response; section 2 & 11.5.

2. **Does human-body equilibrium evolve over time?**

Handled in the forthcoming equilibrium draft (dynamic set-points and stability).

3. **Do changing markers mean improved equilibrium?**

Only if 30-day stability holds and the AF CI test passes; markers alone are not sufficient.

4. **Is a theoretical model feasible with adaptations to available data?**

Yes - we provide data-tiered operation with proxies and documented uncertainty (§8, §9.1).

5. **Any idea about available pilot data?**

Yes - availability tiers listed in §9.1 (high/medium/low).

6. **How do indicators relate to each other?**

Documented via correlation/sign table and PSD checks (§6.1–§6.4).

7. **What does 'improve equilibrium' mean?**

Higher E with statistical AF and 30-day stability; plus better M, lower S and Q.

8. **Do you expect the state to change for the same system?**

Yes - with policies/infrastructure; we re-baseline and re-test (§4.1, §8.1).

9. **If the reference point changes, how quantify gains?**

Use functional comparability (§8.1) and topology-aware entropy normalization.

10. **Is there a variable table?**

Yes - §2 includes a full indicator table and data dictionary.

11. **Will DEFF and S overlap?**

Minimal by design: input vs output; both can co-occur but measure different constructs.

12. **Difference between DEFF and ST?**

DEFF = disturbance magnitude (event); S = network stress response (congestion load).

13. **Why Theil-T over Gini?**

We support both; Theil-T enables within/between group decomposition; choose per use case.

14. **Which data are difficult to obtain?**

EV-grid SCADA and real-time ICT; proxies and fallbacks are specified (§2 notes, §9.1).

15. **Is there a limit for antifragility?**

No fixed cap; decisions use city-specific statistical thresholds (§12.1).

16. **Is κ=0.1–0.2 temporary/adjustable?**

Yes - calibrated per city and re-estimated after major events (§4.3).

17. **How to validate that +10% is not just adaptation/transition?**

Require 30-day stability + AF CI + no active interventions (§7.3, §11.2).

18. **How to be sure this leads to a new equilibrium?**

Confirm steady-state tests (low slope, bounded variance, sustained performance).

19. **Should we repeat measurements after disruption?**

Yes - daily/weekly checks for 6–8 weeks and annual confirmation (§11.9).

20. **How do we quantify change in equilibrium?**

Will be detailed in the equilibrium draft (ΔE* and variance/stability tests).

21. **Is equilibrium like a Pareto frontier?**

Different concepts; equilibrium draft will map UE/SO/Pareto relations explicitly.

22. **What is the relaxation equation derived from; is it related to the literature review?**

Yes - from control/dynamical systems; $\bar{E}(x)$ is built from indicators synthesised in our review; v2 cites and implements this.

23. **How is AF > 1.1 defined and can it be changed?**

v2 allows city-specific calibration and CI-based validation.

24. **How should C(t) change during disruption and is it tied to topology?**

Topology bounds entropy; flows set realised C(t). Typical path: down → up → possibly above baseline; v2 documents this.

25. **Are P(t) ridership weights daily?**

Weights update weekly/monthly; P(t) computed daily with latest weights; AFC data cover >90% of trips; in v2.

26. **What is EV-grid availability and fallback?**

SCADA sites: real-time; otherwise proxies (uptime reports, operator bulletins) or default normal=1.0 with flag; in v2.

27. **What is Grid SCADA and which metrics do we use?**

SCADA supervises EV charging, depots, traction power, signals; metrics include voltage stability, uptime, utilisation, outages, PQI; v2 lists fallbacks.

28. **What is I(t) synergy between which systems and how measured?**

Across modes (bus–metro, bike–rail, P+R); based on interchange distance, transfer times, integrated payments; normalisation method specified in v2.

29. **Why high entropy is not necessarily chaos?**

We evaluate C jointly with performance E; high C with good E = healthy diversity; with poor E = chaos; v2 states this check.

30. **How are first/total-order sensitivity indices determined?**

Standard variance-based (Sobol-style) definitions; procedure summarised in v2 appendix.

31. **Do disruptions spread or concentrate flows and how does that affect C?**

Both patterns occur; C reflects dispersion; interpretation uses E to classify outcome; covered in v2.

32. **How do we redefine maximum entropy after disruption?**

We recompute C_max using available topology and normalise C accordingly; implemented in v2.

33. **What is the 'composite of uptime × spare capacity' for EV charging?**

Indicator multiplies operational uptime by spare capacity proportion to reflect charging resilience; defined in v2.

34. **What does "D_eff uses exponential recency and weights" mean?**

It downweights older shocks, includes diversity influence, and captures congestion nonlinearity; v2 keeps the structure, with parameter ranges to be finalised.

35. **Does the D_eff equation apply to all disturbances?**

Yes, with type-specific weights (transport, weather, utilities, social); v2 documents the calibration idea.

36. **What actions raise R, I, P, or lower Q?**

Examples: pop-up lanes ↑R, coordinated bike–rail hubs ↑I, smart pricing ↑P, targeted services ↓Q; included in v2.

37. **How to compare pre/post when the network fundamentally changed?**

Treat as structural change: re-baseline, recompute C_max, and restart stability/AF tests; v2 states this protocol.

38. **Should AF be variable with $\bar{E}$ (baseline performance)?**

Yes - v2 includes a baseline-dependent threshold option; fixed 1.1 kept for comparability.

Note: This status reflects v2 without the Equilibrium Annex; equilibrium-related items are reserved for the forthcoming equilibrium draft.