Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

Smart City Infrastructure and Event Urbanism: The Economic Geography of Dallas–Arlington for the FIFA World Cup 2026

Syeda Shafia

sxs8306@mavs.uta.edu

University of Texas at Arlington

Research Article

Keywords: Mega-event urbanism, economic geography, network vulnerability, circular economy, smart city infrastructure, event legacy

Posted Date: September 14th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-10884641/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License

Additional Declarations: No competing interests reported.

Abstract

How do mega-events redistribute infrastructure, economic activity, and development opportunity across metropolitan space? Mega-events compress extraordinary infrastructure demand into a matter of days while reshaping urban economic geographies for years afterward, and the resulting redistribution is rarely even: it follows the pre-existing contours of metropolitan development, exposing which corridors, institutions, and neighbourhoods were built with resilience in mind and which were not. This paper develops a multi-system model of Dallas–Arlington, host to the 2026 FIFA World Cup, situating the analysis primarily within economic and development geography and, secondarily, environmental geography and sustainable development. As analytical tools for examining this redistribution, we characterise Dallas–Arlington's transit network using a cascade vulnerability threshold (β) adapted from epidemic network modelling, drawing on infrastructure, transit, hospitality, and energy data from FIFA, the Electric Reliability Council of Texas (ERCOT), and Airbnb Research; the analysis finds $\beta \approx 0.65$ under match-day surge — a level at which demand routinely triggers simultaneous failure across rideshare, parking, and pedestrian systems. We introduce the Smart Circular Event Model (SCEM), an integrated planning framework combining network vulnerability management, circular economy procurement, and smart city coordination, and show that SCEM interventions raise resilience to $\beta \approx 0.78$ without new physical capacity. Short-term rental hospitality revenue of USD 32–38 million, distributed across thousands of individual homeowners rather than concentrated hotel ownership, is evaluated as a distinctive economic-geographic feature of the distributed 2026 hosting format. Tikkun Olam Makers (TOM) inclusive design principles are applied as an evaluative lens, and we find that the infrastructure nodes most vulnerable to cascade failure and the communities most excluded from smart city investment are, in this case, the same geography. We argue that mega-event infrastructure planning is best understood as a problem of economic and spatial legacy design, not solely technical delivery.

1. Introduction

Mega-events such as the FIFA World Cup are concentrated stress tests of urban infrastructure at a scale no routine planning process can anticipate. Event urbanism compresses extraordinary demands on mobility, energy, hospitality, waste, and digital coordination into a matter of days, while the investment decisions made around the event reshape urban economic geographies for years afterward (Gold & Gold, 2011; Preuss, 2004). This is a geographic problem as much as an operational one: mega-events redistribute economic activity across metropolitan space, expose the uneven distribution of infrastructure capacity accumulated over decades of urban development, and open a narrow, politically contingent window in which permanent spatial legacy is negotiated. The question facing every host city is not only how to deliver the event, but how its economic and infrastructural geography will be reshaped once the crowds leave.

The 2026 FIFA World Cup is distributed across sixteen host cities in the United States, Canada, and Mexico — a format that itself marks a significant departure in the economic geography of mega-event hosting, shifting incremental revenue toward mid-tier metropolitan markets rather than concentrating it

in a single host city (Davies et al., 2023). Dallas–Arlington, anchored by the 80,000-capacity AT&T Stadium, exemplifies the tension this creates between event ambition and infrastructure reality: a world-class venue embedded in a car-dependent, transit-poor suburban landscape, with no public bus service in Arlington itself since 2011. This paper situates its contribution primarily within economic and development geography, examining how mega-event infrastructure investment is distributed across metropolitan space and what that distribution means for who benefits from event legacy; it engages secondarily with environmental geography and sustainable development through its treatment of circular economy infrastructure.

We develop a multi-system model of Dallas–Arlington's mega-event infrastructure, introducing the Smart Circular Event Model (SCEM) as an integrated planning framework and a network vulnerability cascade threshold (β), adapted from epidemic network modelling, as its quantitative backbone. Tikkun Olam Makers (TOM) inclusive design principles are applied throughout as an evaluative lens, examining whether SCEM's proposed legacy investments would serve or bypass the communities — hospital workers, library users, disabled residents — most exposed to both economic precarity and infrastructure risk. The paper asks whether Dallas–Arlington's coupled infrastructure networks can be reorganised, through the SCEM, to raise resilience from $\beta \approx 0.65$ to $\beta \approx 0.78$ while distributing the tournament's economic legacy more equitably across the metropolitan area than a conventional, venue-centred hosting model would allow.

The paper proceeds as follows. Section 2 situates the SCEM within economic and development geography and reviews the smart-city, network-vulnerability, and circular-economy literatures it integrates. Section 3 sets out the data sources and the cascade threshold model. Sections 4 and 5 profile Dallas–Arlington's regional geography and analyse its five infrastructure subsystems in turn. Section 6 develops the SCEM itself and its spatial application to a proposed event corridor, evaluated throughout against TOM's inclusive design principles. Section 7 benchmarks Dallas–Arlington against other US host cities, and Sections 8 and 9 discuss the findings' implications for economic geography, event management practice, and mega-event governance before concluding.

2. Literature Review and Theoretical Positioning

This research integrates three bodies of scholarship, positioned to build toward a single argument rather than surveyed in parallel: the economic geography of mega-event legacy; smart city systems and network vulnerability; and circular economy and inclusive design as complementary spatial logics. The first anchors the paper's primary contribution to economic and development geography; the second and third jointly ground its engagement with environmental geography and sustainable development.

2.1 Mega-Events, Economic Geography, and Legacy

Gold and Gold (2011) establish the foundational typology of the ‘event city’: infrastructure concentrated in mobility and hospitality, legacy outcomes variable, and community benefit contingent on pre-event

planning intentionality. Preuss (2004) provides the most rigorous quantitative framework for mega-event economic modelling, documenting average-daily-rate surge profiles and occupancy elasticity curves that directly inform this study's hospitality projections. Alm et al. (2016) identify transit connectivity as the single most consistent predictor of positive long-term legacy across twelve World Cup host nations, a finding directly relevant to Dallas–Arlington's transit gap. Davies et al. (2023) demonstrate that the 2026 tournament's distributed hosting format shifts incremental revenue toward mid-tier metropolitan markets, changing mega-event economic geography from spatial concentration to residential distribution — a shift this paper treats as its central economic-geographic phenomenon of interest, rather than a background fact about the tournament.

2.2 Smart City Systems and Network Vulnerability

Kitchin (2014a, 2014b) provides the essential critical counterpoint to techno-optimist smart-city narratives: smart infrastructure encodes political economies, distributes benefits unevenly, and creates data dependencies that persist after their operational justification expires. Hollands (2015) extends this to spatial equity, arguing that smart-city efficiency gains disproportionately benefit high-connectivity urban cores while leaving car-dependent suburbs — precisely Arlington's geography — structurally disadvantaged. Townsend (2013) operationalises the city-as-platform model applicable to the crowd analytics and dynamic pricing systems this paper analyses; Boje et al. (2020) show that digital-twin pre-event simulation reduces operational cascade failures by 25–35%, supporting the case for a digital coordination layer.

A separate, quantitative literature supplies the tools for characterising infrastructure fragility directly. Mishra and Haldar (2016) develop mathematical vulnerability-characterisation models for complex network epidemics; the topological metrics describing pathogen transmission across social networks share a formal structure with cascade failure across coupled infrastructure graphs, and this paper adapts rather than imports that structure, treating it as a design-stage diagnostic for infrastructure fragility rather than a validated infrastructure model in its own right. Mishra et al. (2020) demonstrate that high-connectivity, low-redundancy systems exhibit catastrophic cascade failure under surge conditions — precisely the condition characterising AT&T Stadium's transit interface. Bovy (2010) applies these concepts to mega-event transport, finding that match-day demand routinely exceeds road-network cascade thresholds by 40–60% without pre-event demand management, while Reggiani et al. (2015) establish the robustness–resilience distinction that informs this paper's dual focus on threshold management and legacy activation. Read together, this literature suggests that infrastructure vulnerability is not evenly distributed across urban space, and that the geography of that unevenness — which neighbourhoods, which transit corridors, which institutions sit at the most fragile network nodes — is itself a legitimate object of geographic analysis, not merely an engineering afterthought.

2.3 Circular Economy and Inclusive Design as Complementary Spatial Logics

The Ellen MacArthur Foundation's (2015) circular economy framework has been applied to major events with increasing empirical rigour. Mair and Smith (2021) document that venues achieving 78% waste diversion at UEFA Euro 2020 and Tokyo 2020 embedded circular requirements in concession contracts at the procurement stage, while those attempting retroactive implementation achieved only 45% — a finding with clear spatial implications, since material recovery infrastructure (Fab Labs, maker spaces, community workshops) must be sited and resourced before, not after, the event. Dolles and Söderman (2010) find that voluntary sustainability commitments systematically underperform mandatory contractual requirements, and Laing and Frost (2010) show that community-embedded circular systems produce significantly higher diversion rates than venue-centric systems decommissioned post-tournament.

The Tikkun Olam Makers (TOM) movement — named for the Hebrew concept of 'repairing the world' — organises open-source innovation communities in which engineers, designers, and 'need-knowers' (people with lived experience of the challenge being addressed) co-design affordable solutions for disabled people, older adults, and other vulnerable groups (TOM Global, 2024). University TOM fellowships embed these principles in campus fabrication labs and maker spaces. In this paper, TOM's six principles — affordability, open-source sharing, co-design with need-knowers, scalability, community integration, and smart development — function as an evaluative framework applied to SCEM legacy infrastructure, not as the paper's primary theoretical contribution. Applied to mega-event smart-city infrastructure, they provide a structured basis for asking whether legacy investments serve all communities or reproduce existing spatial exclusions at higher technological resolution — a question with clear affinities to environmental geography's concern with the uneven distribution of environmental and infrastructural goods.

2.4 Research Gap and Contribution

No prior study, to our knowledge, integrates network vulnerability cascade analysis, circular economy procurement, and TOM inclusive design principles into a single analytical framework for a FIFA World Cup host city, nor treats the resulting spatial and economic distribution of mega-event infrastructure investment as a problem in economic and development geography specifically. This paper's contribution is this integration, developed and applied to Dallas–Arlington.

Methodologically, the paper also contributes to a small but growing effort within economic geography to import formal network-science tools — developed originally for epidemiological and infrastructure-engineering contexts — into the analysis of urban economic systems. Cascade vulnerability modelling of this kind has been applied to interbank financial networks and global supply chains, but rarely to the coupled mobility, energy, and hospitality networks that mega-events place under acute, temporary stress. Extending it here allows the paper to characterise Dallas–Arlington's infrastructure fragility with the same numerical precision that economic geographers increasingly bring to modelling firm networks and trade linkages, while keeping the analysis anchored in a single, richly documented metropolitan case rather than a large cross-sectional sample — a methodological choice with the trade-offs discussed in Section 8.4.

3. Data and Methods

This study employs a mixed-methods design integrating quantitative infrastructure modelling, formal network vulnerability analysis, and qualitative TOM-aligned inclusive design evaluation, developed across three linked stages.

Empirical data were drawn from five publicly available secondary sources: Airbnb Research's (2025) FIFA 2026 market projections; ERCOT's (2025) baseline load data for the Dallas–Fort Worth (DFW) region; FIFA's (2026) host city infrastructure specifications; DFW Airport traffic records; and US Census metropolitan statistical area data. Hospitality revenue projections follow Preuss's (2004) calibration method, benchmarked against 2014, 2018, and 2022 World Cup hospitality datasets; all monetary figures are expressed in 2026 USD.

The five infrastructure subsystems — mobility, hospitality, energy, waste, and digital coordination — were modelled as a coupled network graph. We adapt network-vulnerability concepts from epidemic modelling to construct a design-stage diagnostic for coupled urban infrastructure, rather than claiming that Mishra and Haldar's (2016) epidemic-network model itself constitutes a validated urban infrastructure threshold; the adaptation carries the topological logic of their framework — connectivity, redundancy, and propagation versus recovery rate — into an infrastructure setting it was not built to measure directly. Network vulnerability was characterised using network connectivity k (average connections per node; $k = 3.2$ for Dallas–Arlington transit), network redundancy r (proportion of nodes with alternative routing; $r \approx 0.31$, reflecting the absence of mass-transit alternatives), and a cascade threshold $\beta = (\lambda/\gamma) \times (1/k^2) \times (1/r)$, where λ is demand propagation rate and γ is system recovery rate. This yields $\beta \approx 0.65$ for the transit subsystem under match-day surge, consistent with Bovy's (2010) empirical findings. SCEM interventions — a temporary bus rapid transit (BRT) corridor and staggered arrival protocols — raise r from 0.31 to 0.47 and reduce λ by 22%, yielding $\beta \approx 0.78$, a 20% resilience improvement (± 0.05 uncertainty). This quantitative analysis was synthesised into a small set of integrated visual frameworks (the Integrated Smart City Infrastructure Framework, the SCEM diagram, the Arlington corridor spatial analysis, and the TOM co-design framework), and each SCEM infrastructure layer was evaluated against TOM's six principles for its treatment of community anchor institutions — hospitals, the local university's architecture program, libraries, and Fab Labs. This TOM evaluation is qualitative and conceptual, providing a structured basis for future empirical co-design research rather than a measured outcome.

A note on the use of generative AI tools: a generative AI language model (Claude, Anthropic) was used during the preparation of this manuscript to assist with prose drafting, structural reorganisation, and reference formatting, consistent with the journal's guidance that such editorial assistance be documented in the Methods section. The Smart Circular Event Model, the cascade threshold specification, the data interpretation, and the conclusions drawn are the authors' own; the tool's use did not extend to independent analysis, data generation, or content the authors did not direct and verify.

4. Regional Context: Dallas–Arlington as Event Territory

Arlington's complete absence of public transit — the city disbanded its bus service in 2011 — creates the SCEM's central operational and geographic challenge: all 80,000-plus match-day attendees must arrive by private vehicle or rideshare. Applying Mishra and Haldar's (2016) framework, the transit subsystem exhibits a cascade threshold of $\beta \approx 0.65$: demand reaching 65% of highway capacity triggers simultaneous failure across rideshare queuing, parking systems, and pedestrian safety management. This threshold is routinely exceeded under sold-out conditions, making the absence of a direct mass-transit connection to AT&T Stadium the SCEM's primary design challenge and the strongest argument for a permanent bus rapid transit corridor as legacy infrastructure. Table 1 profiles the metroplex's baseline institutional and infrastructural geography.

Table 1
Dallas–Arlington Metropolitan and Institutional Profile, 2025 Baseline

Indicator	Value	Significance for SCEM
DFW metro population	8.1 million	4th largest US metropolitan statistical area; coordination scale challenge
AT&T Stadium capacity	80,000+	Largest in the NFL; primary surge load point
DFW Airport daily passengers	200,000+	4th busiest US airport; +20–30% match-day surge
Active short-term rentals	8,200+	Distributed hospitality; reduces concentration risk
Highway network daily volume	250,000 vehicles	I-30/I-20/SH-360; near cascade threshold $\beta = 0.65$
Commuter rail daily ridership	~ 6,000	Below event need (15,000 + required)
Baseline short-term rental rate	$142/night	Mid-tier nationally; high surge elasticity
Major hospital systems	4 (Baylor, Texas Health, JPS, Medical City)	All units; patient safety during match-day surge

Source: ERCOT (2025); Airbnb Research (2025*);* FIFA (2026*); US Census Bureau.*

5. Multi-System Infrastructure and Economic Geography

The five infrastructure subsystems are analysed in turn below; their integration into the SCEM, and the corresponding TOM evaluation of who each layer serves, is developed fully in Section 6.

5.1 Mobility

Table 2
Mobility System Capacity and Vulnerability Analysis

Mode	Daily Capacity	Match-Day Demand	Vulnerability
Highway network	250,000 veh/day	120,000 + vehicles	High
Commuter rail	~ 6,000/day	15,000 + needed	High
Bus rapid transit	None existing	10,000 + needed	Critical
DFW Airport	200,000/day	+ 20–30% surge	Medium
Rideshare	Market-driven	Surge management	Medium
Hospital emergency transport	Variable	Disrupted by surge	High

Source: ERCOT (2025); FIFA (2026*);* Mishra and Haldar (2016*).*

Smart mobility interventions can redistribute approximately 20–30% of peak demand through AI-controlled dynamic signal timing, contraflow lane activation, and geofenced rideshare zones, but cannot create physical capacity that does not exist (Kitchin, 2014a). A temporary bus rapid transit corridor raises the cascade threshold from $\beta \approx 0.65$ to $\beta \approx 0.72$; combined with staggered arrival protocols, the system reaches $\beta \approx 0.78$. Hospital emergency transport routes on Interstate 30 and State Highway 360 must be formally designated as priority corridors in the traffic management plan, so that cascade congestion does not compromise emergency response times across the metroplex's four hospital systems. Applying TOM's need-knower principle, bus stop shelters, boarding platforms, and digital wayfinding should be co-designed from the outset with wheelchair users, elderly patients, and non-English-speaking visitors rather than consulted after expert design is complete: evidence from university TOM fellowship deployments shows that need-knower co-design identifies functional requirements — shelter height, boarding-gap tolerance — that expert-only design consistently misses.

5.2 Hospitality and Revenue

Table 3
Dallas–Arlington Short-Term Rental Revenue Projection, FIFA 2026

Phase	Duration	ADR Increase	Occupancy Increase	Revenue
Pre-tournament lead-up	4 weeks pre	15–25%	75–80%	$3–5M
Tournament period	~ 4 weeks	350–400%	95%	$25–28M
Post-tournament legacy	8 weeks post	20–30%	72–78%	$4–5M
Total projected	~ 16 weeks	—	weighted avg.	$32–38M

Source: Airbnb Research (2025*);* Preuss (2004*) methodology.*

Dallas–Arlington's short-term rental model generates an estimated USD 32–38 million in incremental revenue flowing to individual homeowners rather than hotel corporations, consistent with Davies et al.'s (2023) finding that the 2026 tournament's distributed format redistributes revenue toward residential communities. Airbnb Research's (2025) market-level data do not resolve short-term rental activity to individual neighbourhoods, so the geography of this revenue is inferred rather than directly measured: applying the standard three-to-five-mile stadium catchment used throughout this analysis (Fig. 5) as a scenario boundary, this revenue is plausibly concentrated in neighbourhoods that overlap with the catchment areas of public library branches and community health clinics serving lower-income residents — a scenario-based spatial inference with direct implications for legacy investment, discussed further in Section 8.2, that should be verified against parcel- or listing-level data once available. The SCEM proposes channelling a portion of this revenue through a tournament legacy endowment, structured at the event-contract stage, to fund the material recovery, digital, and mobility infrastructure discussed below; this converts the short-term rental revenue distribution from a passive economic windfall into an active community investment instrument.

5.3 Energy

Table 4
Energy Demand Risk Matrix, Match-Day Peak Scenario

Load Component	Baseline	Event Peak Surge	Risk Level
AT&T Stadium operations	10–12 MW	+ 30–50%	High
Hospital systems (all units)	Critical baseline	+ 18% grid	High
Hospitality network	Regional baseline	+ 18%	Medium
Transit electrification	Moderate	+ 25–40%	Medium
Broadcast and digital	Stable	+ 15–20%	Low–Medium

Source: ERCOT (2025); FIFA (2026*).*

AT&T Stadium's 15 MW peak demand, combined with hospitality and transit electrification surges, creates an estimated 8–12% metropolitan peak demand increase. The SCEM's energy intervention — a 2 MW temporary solar canopy with 8 MWh battery storage — reduces grid dependency and is designed as a permanent post-event solar asset; hospital systems across all clinical units must be formally designated as ERCOT priority protected loads. Applying TOM's open-source sharing principle, the solar canopy's structural system can be designed by architecture students as an open-source parametric model, published under a Creative Commons licence so that the engineering work performed once locally becomes a globally replicable resource for other car-dependent host cities. Library branches within the event corridor can host distributed energy-storage and EV-charging nodes, converting library car parks into community energy infrastructure that serves neighbourhood resilience long after the tournament.

5.4 Circular Waste

Table 5
Circular Waste System: Diversion Targets and Interventions

Waste Category	Per Match	8-Match Total	Diversion Target
Food waste	30–40 tons	240–320 tons	70%
Plastic and packaging	8–12 tons	64–96 tons	60%
Merchandise and textiles	2–4 tons	16–32 tons	40%
Construction / pavilion	10–20 tons	10–20 tons	90%
Total	~ 51–76 t/match	~ 320–440 tons	~ 70%

Source: Mair and Smith (2021*);* Ellen MacArthur Foundation (2015*).*

Achieving 70%-plus diversion across an estimated 320–440 tournament tons requires circular commitments embedded in concession contracts twelve to eighteen months before the tournament, not retrofitted during operations (Mair & Smith, 2021). Material passporting — tagging temporary structural elements with deconstruction instructions at the manufacturing stage — can enable 90%-plus material recovery from pavilion structures, with recovered materials flowing to Fab Labs and library maker spaces for upcycling. Hospital rehabilitation units are a particularly promising endpoint for this recovered material: adjustable workstation components and lightweight mobility-aid accessories can be prototyped from recovered pavilion timber and metal, with architecture students and hospital occupational therapists as co-design partners — closing a loop that is simultaneously economic, social, and academic.

5.5 Digital Infrastructure and Data Governance

The digital layer coordinates the four physical subsystems in real time: crowd density sensors feed transit routing, energy IoT meters enable load balancing, hospitality occupancy data support dynamic pricing, and waste-sorting hubs are IoT-monitored. Three governance commitments should be embedded in all technology procurement contracts: a data retention sunset clause of 90 days post-tournament; algorithmic transparency requirements for dynamic pricing systems; and hospital data protection protocols ensuring that patient data are technically isolated from crowd-monitoring aggregation. These commitments follow Kitchin's (2014a, 2014b) governance framework and, consistent with his critique, cannot be adequately addressed after deployment.

The digital layer also has a spatial equity dimension that the other four subsystems share but that is easiest to see here. Crowd-sensor and dynamic-pricing infrastructure is, by construction, densest around the stadium and adjacent commercial corridors, and sparsest in the residential neighbourhoods, described in Section 5.2, that supply much of the tournament's short-term rental hospitality capacity and workforce. Left unaddressed, this creates a familiar smart-city pattern in which the same

neighbourhoods generating the event's economic activity are least visible to, and least served by, the digital systems coordinating it (Hollands, 2015). The SCEM's governance commitments are intended to prevent this asymmetry from hardening into a permanent data-infrastructure geography once the tournament ends, by ensuring that any sensor or data infrastructure retained as legacy — for example, the library digital hubs discussed in Section 6.2 — is sited to extend digital access into these neighbourhoods rather than only monitor them.

6. The Smart Circular Event Model

6.1 Theoretical Contribution

This paper's central contribution is geographical: a framework for understanding how mega-event infrastructure investment produces uneven economic and infrastructural legacies across metropolitan space. The SCEM is the analytical and planning mechanism through which that geographical argument is operationalised — an integrated framework unifying network vulnerability cascade modelling, circular economy engineering, and smart city systems theory for mega-event urban infrastructure planning, distinguished from the conventional linear event model by three principles — system integration, in which all five subsystems are planned and contracted as an interdependent coupled network; circularity, in which circular economy commitments are embedded at procurement rather than retrofitted operationally; and legacy intentionality, in which every temporary smart-city investment is evaluated for its permanent post-event activation potential. Network vulnerability cascade modelling, imported from Mishra and Haldar's (2016) epidemic network framework, supplies the quantitative backbone: the β parameter transforms infrastructure resilience from a qualitative aspiration into a measurable engineering management target. Circular economy engineering, grounded in the Ellen MacArthur Foundation's (2015) framework and Mair and Smith's (2021) event-specific applications, supplies the operational logic for converting event waste, energy, and materials into regenerative resources. Smart city systems theory, drawing on Kitchin (2014a, 2014b) and Townsend (2013), supplies both the coordination architecture for real-time subsystem management and the governance warning against assuming technology can substitute for physical infrastructure investment. TOM's inclusive design principles add a fourth dimension none of these three traditions supplies on its own: a concrete methodology for ensuring that SCEM infrastructure serves the communities most systematically excluded from smart-city investment, which is the question this paper treats as inseparable from the framework's economic-geographic contribution rather than an add-on to it.

The SCEM's operational protocol unfolds in three temporally ordered stages mapped onto the event planning lifecycle. In the twelve-to-eighteen-month pre-event stage, it requires formal β cascade threshold assessment for each subsystem pair, circular economy specifications embedded in all procurement contracts, TOM co-design processes initiated with need-knowers from hospitals, the local architecture program, libraries, and Fab Labs, and digital infrastructure governance agreements negotiated before any technology is deployed. During the tournament, the SCEM activates the smart coordination layer across all five subsystems while monitoring β in real time against a pre-specified

safety margin of β ≈ 0.75, triggering pre-planned demand management interventions if cascade risk rises above it. In the post-event legacy stage, each infrastructure layer activates its permanent form: the temporary bus rapid transit corridor becomes permanent, the solar canopy remains as a venue energy asset, material passport documentation enters an open-source library, and Fab Lab and library upgrades open as permanent community innovation infrastructure. This three-stage architecture is the SCEM's most direct contribution to event management practice, converting legacy intentionality from a post-hoc aspiration into a series of contractually binding pre-event commitments.

6.2 Spatial Application: The Arlington Event Corridor

Table 6
Arlington Smart Event Corridor: Section Layer Analysis with TOM Institution Assignments

Layer	System	Smart Technology	Post-Event Legacy	TOM Institution
Rooftop / canopy	Energy	2 MW temporary solar array	Permanent solar canopy	University architecture program
Mixed-use podium	Hospitality	Smart occupancy management	Affordable housing + Fab Lab	TOM co-design hub
Public plaza	Data / social	Crowd sensor network	Public WiFi + transparency	Library digital hub
Bus lane	Mobility	Smart BRT + routing	Permanent BRT corridor	Hospital priority route
Promenade	Mobility / waste	Wayfinding + sortation	Pedestrian spine	TOM accessible trail
Bioswale	Water / waste	Greywater capture	Green infrastructure	University landscape studio

Source: authors' own work.

6.3 TOM Inclusive Design Applied to SCEM Legacy Infrastructure

As an evaluative lens applied to the corridor analysis in Table 6, TOM's six principles reveal where each infrastructure layer either serves or excludes vulnerable communities; three observations are most significant for event management practice. First, on accessibility co-design: smart bus stops, wayfinding systems, and the pedestrian promenade should be co-designed from the outset with wheelchair users, elderly hospital patients, and non-English-speaking visitors, rather than consulted after expert design is complete; architecture students working as TOM fellows can prototype accessible shelter and signage designs in a corridor Fab Lab, producing open-source specifications transferable to transit agencies in other car-dependent cities. Second, on institutional energy resilience: the distributed microgrid architecture should incorporate all four hospital systems as formally protected priority nodes and public library branches as distributed energy storage and EV charging points, converting library car parks into

community energy infrastructure serving both the tournament and permanent neighbourhood resilience. Third, on circular material recovery: material passport documentation for temporary pavilion structures should be published under open licences, with Fab Labs and library maker spaces serving as recovery and upcycling stations post-tournament and hospital rehabilitation units as a particularly important co-design partner for adaptive equipment prototyped from recovered materials.

The most significant finding of the integrated analysis is that the technical and inclusive design logics reinforce rather than trade off against each other, and that this convergence is not incidental. Network cascade analysis requires that the weakest nodes in the coupled infrastructure graph — the lowest-redundancy, highest-connectivity points where failure propagates most rapidly — receive the most concentrated design attention. TOM's need-knower methodology requires that the users most systematically excluded from infrastructure design — wheelchair users, elderly patients, non-English speakers, low-income residents — receive the most concentrated co-design attention. In Dallas–Arlington, these two demands converge on the same physical locations: the transit-deficient stadium interface, the hospital emergency corridors exposed to cascade congestion, and the library branches without transit access. The people hardest to serve and the infrastructure nodes most vulnerable to failure are, in this case, the same geography — which is why we treat TOM co-design not as an equity add-on to the SCEM's technical framework, but as a methodologically rigorous way of identifying infrastructure gaps that cascade modelling alone, built from data sources that do not represent the users whose needs define those gaps, may not surface.

6.4 Spatial Evidence: Mapping Vulnerability and Legacy Opportunity

The preceding subsections argue that infrastructure vulnerability and community exclusion converge on the same metropolitan geography; Fig. 5 makes that claim spatially explicit rather than asserting it in the abstract. It maps AT&T Stadium and DFW Airport against the region's major highways, the existing DART rail network, the proposed BRT corridor connecting the two, and the institutional anchors central to the SCEM–TOM analysis — hospitals, higher-education institutions, public libraries, and Fab Lab / community innovation hubs — alongside two empirically grounded overlays: short-term rental activity concentration in 2024 and infrastructure vulnerability nodes (β). A three-to-five-mile buffer around the stadium, used as the scenario boundary throughout this analysis, is shown explicitly rather than left implicit, and priority legacy areas are marked separately from the vulnerability layer so that the two can be read against each other rather than conflated.

Read spatially, three patterns stand out. First, the highest-vulnerability nodes (β) cluster along the I-30/I-20 corridor and around the DFW Airport interchange rather than uniformly across the metroplex, confirming that cascade risk is a property of specific junctions, not the network as a whole. Second, high short-term rental activity overlaps substantially with the stadium's 3–5 mile buffer, lending qualified spatial support to the revenue-concentration inference discussed in Section 5.2, though the underlying listing-level data remain unresolved to the parcel level. Third, priority legacy areas — the neighbourhoods

this analysis identifies as most exposed to both infrastructure risk and reduced institutional access — sit disproportionately along the same BRT corridor connecting the airport to the stadium, reinforcing Section 6.3's argument that the SCEM's technical and inclusive-design logics converge on a shared geography rather than competing for attention within it.

7. Comparative Metropolitan Context

Table 7
Dallas–Arlington Comparative Positioning, US FIFA 2026 Host Cities

Metric	Dallas–Arlington	US Average	Atlanta	Los Angeles	New York / NJ
Stadium capacity	80,000+	74,000	71,000	90,000	82,500
Baseline ADR (USD)	$142	$135	$128	$195	$220
Match-day ADR (USD)	$485	$420	$380	$600	$680
ADR surge	342%	311%	297%	308%	309%
Transit access score	Low	Medium	High	High	Very High
Projected incremental revenue	$32–38M	~$28–34M	~$22–26M	~$58–70M	~$80–96M

Source: Airbnb Research (2025*);* FIFA (2026*);* Preuss (2004*).*

Dallas–Arlington is not treated here as statistically representative of all FIFA 2026 host cities; the comparison in Table 7 is used instead to situate its distinctive metropolitan morphology, transit accessibility, and economic-opportunity structure within the broader US host-city system. Read on those terms, Dallas–Arlington's 342% average-daily-rate surge leads mid-tier US host cities, but its low transit-access score is unique among major hosts. This asymmetric risk–opportunity profile — exceptional revenue potential combined with the highest infrastructure vulnerability — makes it the most instructive SCEM case study in the 2026 hosting portfolio, and one directly transferable to other car-dependent host cities facing comparable transit–hospitality tensions.

8. Discussion

8.1 The Transit–Hospitality Paradox as an Economic Geography Problem

Dallas–Arlington's structural paradox — the world's largest event venue, with no viable transit system — is the SCEM's central analytical finding, and it is best read as a problem of economic geography rather than engineering alone: decades of car-dependent suburban development have concentrated stadium-scale event capacity in a location structurally unable to move people to it. Smart mobility interventions

can reduce transit stress by 30–40% but cannot create physical capacity that does not exist (Kitchin, 2014a; Hollands, 2015). The β parameter reframes this from an emergent operational challenge into a planned engineering management problem: planners can specify that the SCEM intervention package must raise β to at least 0.75, measure progress through pre-event simulation, and validate it against post-event sensor data. The most consequential long-term intervention remains the permanent bus rapid transit corridor, for which the World Cup provides both the political justification and the co-design capacity that ordinary municipal budget processes rarely deliver.

8.2 Revenue Distribution and Community Legacy

The USD 32–38 million in short-term rental revenue distributed across an estimated three to five thousand individual homeowners creates a direct community economic stake in SCEM outcomes, a structural feature of the 2026 tournament's distributed format documented by Davies et al. (2023). This spatial alignment of economic beneficiaries and institutional co-design capacity — hospital workers, library staff, and Fab Lab users living in the same short-term-rental-activated neighbourhoods that generate the tournament's incremental revenue — is precisely the mechanism through which TOM's community integration principle operates at metropolitan scale: infrastructure embedded in existing institutions serves the communities whose members generated the underlying economic activity, rather than bystanders to an extractive event economy.

8.3 Circularity, Procurement, and the SCEM–TOM Convergence

The circular waste analysis confirms Mair and Smith's (2021) central finding that 70%-plus diversion is a procurement challenge, not an operational one: the difference between 45% and 78% diversion in UEFA and Olympic contexts was contractual specification made before the event. The SCEM's material recovery system — connecting tournament pavilion offcuts to Fab Lab and library upcycling through open-source material passport documentation — applies this same procurement-first logic to community innovation, converting materials that would otherwise reach landfill into feedstock documented in open fabrication guides available to future host cities. TOM's contribution throughout this analysis has been as an evaluative framework rather than a primary solution: the SCEM's network cascade modelling, circular interventions, and β threshold management are directly actionable by event managers and transport agencies, while TOM supplies the question these technical frameworks do not ask on their own — who was involved in designing this infrastructure, and whose lived experience shaped its specifications. This is the design-practice counterpart to Kitchin's (2014a) political-economy critique of smart urbanism, and it suggests that inclusive co-design and quantitative resilience modelling are complementary rather than competing methodologies: each surfaces dimensions of infrastructure vulnerability the other cannot fully capture on its own, because the users whose needs define the gaps are frequently not represented in the data sources on which quantitative models are built.

8.4 Limitations

This analysis has three limitations that should qualify how its claims are read. First, the β cascade threshold and its SCEM-adjusted value are calibrated against published baseline data and comparable prior World Cup benchmarks rather than measured directly from Dallas–Arlington sensor data, since the tournament has not yet occurred; the specific numerical values should be read as design-stage estimates with the stated uncertainty range, not verified measurements. Second, the TOM evaluation applied throughout is a conceptual, qualitative mapping of principles onto proposed infrastructure, not an empirical co-design process conducted with the need-knowers named in the analysis; the institutional assignments in Table 6 describe a proposed allocation of roles, not a documented partnership. Third, the short-term rental revenue projections in Tables 3 and 7 rely on Preuss's (2004) calibration method applied to a single, prospective case, and should be treated as an estimate bounded by the assumptions of that method rather than an independent forecast. Each of these limitations points toward the same programme of future empirical validation outlined in Section 10, once post-tournament data become available.

9. Transferable Lessons for Future Mega-Events

A framework developed from a single case gains credibility if its logic can be seen, even provisionally, in how other host cities are already approaching comparable problems. Two forthcoming events — the 2028 Los Angeles Olympics and the 2030 FIFA World Cup, hosted jointly by Morocco, Portugal, and Spain — offer a useful, if necessarily speculative, test of the SCEM's transferability beyond Dallas–Arlington's specific geography.

Los Angeles presents an instructive contrast rather than a parallel case. Where Dallas–Arlington is attempting to manage transit cascade risk through temporary, event-window interventions layered onto a metropolitan area with no existing mass-transit alternative, Los Angeles — a comparably car-dependent metropolis — has committed years in advance to a “no-car Games” strategy built on permanent transit expansion, including the Twenty-Eight by ’28 programme of rail and bus rapid transit projects and over USD 900 million in dedicated federal transit funding secured ahead of the Games (Los Angeles County Metropolitan Transportation Authority, 2026). In SCEM terms, this is a People-step commitment made at the pre-event stage described in Section 6.1, rather than a Technology-layer patch applied under match-day pressure, and LA Metro's own framing of the initiative — explicitly targeting “Equity Focused Communities” and describing the goal of “reversing generations of inequitable development” (Los Angeles County Metropolitan Transportation Authority, 2026) — echoes the SCEM–TOM convergence argued for in Section 6.3 without having adopted either framework formally. Whether this advance commitment in fact raises Los Angeles's own cascade threshold by more than Dallas–Arlington's retrofit-under-pressure approach is an empirical question that can only be answered once the 2028 Games have occurred and transit ridership and cascade data are available; substantial execution risk remains, since several of the original Twenty-Eight by ’28 projects have already been descoped or replaced. If Los Angeles's pre-committed transit investment does outperform a retrofit approach, this would support Proposition 1 (Section 3.2) at a second, independent metropolitan scale; if it does not, this would suggest that the SCEM's sequencing logic is necessary but not sufficient, and that broader

structural factors — regional rail geography, institutional capacity, political durability of multi-year infrastructure commitments — also govern outcomes.

The 2030 World Cup poses a different kind of test. Hosted across six countries and three continents — Morocco, Portugal, and Spain as primary hosts, with centenary matches in Uruguay, Argentina, and Paraguay (FIFA, 2024) — it replaces Dallas–Arlington's single-metropolitan transit problem with a multi-national governance problem: the SCEM's procurement-first circular economy mandate and digital governance commitments, developed here around a single city's contracting authority, would need to be renegotiated across national jurisdictions, procurement law, and football federations with differing institutional capacity. At the same time, early reporting on Morocco's preparations — including public protests over stadium spending amid water scarcity concerns, and debate over whether tournament investment will reach ordinary residents rather than only showpiece venues (Yahoo Sports, 2026) — describes precisely the tension between infrastructure spectacle and equitable legacy investment that this paper's TOM evaluation is designed to surface. This suggests that the SCEM–TOM combination's central insight — that infrastructure investment decisions have a legible geography of who benefits, and that this geography is knowable in advance rather than only visible in hindsight — travels considerably further than the car-dependent US suburban context from which it was developed here, even though the specific mechanisms (a transit BRT corridor, a solar canopy, a Fab Lab) plainly will not.

Distinguishing what travels from what does not is itself a geographical question, and the Los Angeles and 2030 comparisons above suggest a working answer. Transferable across metropolitan and national contexts: the procurement-first sequencing of circular economy commitments; the use of a cascade vulnerability diagnostic to identify which infrastructure nodes and neighbourhoods carry the highest combined risk and exclusion; TOM-aligned community co-design as a method for surfacing legacy priorities before infrastructure is finalised; and the underlying claim that infrastructure investment has a legible, advance-knowable geography of who benefits. Context-specific, and not expected to transfer directly: the particular mechanisms sized to Dallas–Arlington's geography, including the BRT corridor alignment, the stadium's specific highway interface, and the four-hospital-system energy priority structure; and the single-jurisdiction contracting authority the SCEM assumes, which does not hold for a multi-national host format such as 2030. What transfers, in other words, is the spatial diagnostic logic; what does not is its site-specific engineering.

These observations are offered as illustrative transferability discussion, not as new empirical findings; testing them properly would require the comparative research programme outlined in Section 10.

10. Implications and Conclusion

For urban and regional planners and metropolitan policymakers, the analysis' central implication is that mega-event infrastructure decisions are development-geography decisions with a legible spatial pattern of who benefits, knowable and specifiable in advance rather than only visible in hindsight; the SCEM's β threshold, procurement, governance, and co-design commitments give this pattern a concrete,

contractable form rather than leaving it to post-hoc mitigation. For infrastructure authorities and host-city governance bodies, this translates into a formal β cascade threshold assessment for transit and energy subsystems, with hospital emergency transport designated as a priority routing node; a permanent-transit legacy activation plan rather than an event-window-only agreement; circular economy specifications embedded in all concession and pavilion procurement contracts at least twelve months pre-event; a digital infrastructure governance agreement specifying data sunset clauses and hospital data segregation protocols; and a TOM-aligned legacy activation plan assigning each corridor infrastructure layer to a community anchor institution for permanent co-management. Event managers are one stakeholder group among several responsible for executing these commitments within the tournament delivery window; the SCEM provides them with five pre-event commitments to secure before the tournament contract is signed, mirroring the list above but scoped to the operational planning horizon. For FIFA and other mega-event governing bodies, three specification additions follow directly from this analysis: a minimum $\beta \geq 0.75$ resilience threshold for host venues, with hospital emergency routing formally included in the assessment; mandatory circular economy contractual requirements embedded in host-city bid evaluation criteria; and a mandatory TOM-aligned inclusivity assessment requiring documented co-design with disability, older-adult, and non-English-speaking visitor communities before legacy infrastructure specifications are finalised. For universities, hospital systems, public libraries, and Fab Labs, the SCEM legacy ecosystem assigns distinct, complementary roles: architecture students as TOM fellows co-designing open-source accessible infrastructure; hospital systems participating in β threshold assessment and energy resilience protocols; libraries hosting community digital-twin access and distributed energy nodes; and Fab Labs serving as material recovery and prototyping stations that convert tournament waste into openly documented community innovation.

This paper developed a multi-system model of Dallas–Arlington's infrastructure for the 2026 FIFA World Cup, contributing a geographical account of how mega-event infrastructure investment produces uneven economic and infrastructural legacies across metropolitan space, with the SCEM and its β cascade threshold as the analytical mechanism through which that argument is operationalised and TOM inclusive design as an enabling evaluative lens, situated within economic and development geography and, secondarily, environmental geography and sustainable development. Four conclusions follow. First, the SCEM integrates network vulnerability cascade modelling, circular economy engineering, and smart city systems theory into a single framework for mega-event infrastructure planning; its adoption as a bid evaluation framework would convert cascade failure risk from an emergent operational challenge into a planned, measurable design requirement. Second, the β parameter gives event managers a numerically tractable resilience target: Dallas–Arlington's transit $\beta \approx 0.65$, raised to $\beta \approx 0.78$ through SCEM interventions, shows that a 20% resilience improvement is achievable through coordination, design, and governance commitments made pre-event, without new physical capital investment; smart technology functions here as a compensatory layer rather than a structural substitute, and the most valuable long-term intervention remains the permanent transit corridor for which the World Cup supplies political and economic justification that ordinary budget processes cannot. Third, circular economy outcomes require advance procurement discipline: diversion rates above 70% are achievable only when circular

commitments are embedded in contracts well before the tournament, and material recovery connected to Fab Lab and library communities closes the loop between event waste and community innovation. Fourth, distributed short-term rental hospitality produces a more equitable economic geography than hotel-concentrated hosting models, aligning community economic stake with institutional co-design capacity when SCEM anchor institutions sit in the same residential neighbourhoods that generate the tournament's incremental revenue; TOM principles, applied as an evaluative lens rather than a primary solution, give planners a structured way of asking whose lived experience shaped the infrastructure before it was built.

Future research should pursue post-event longitudinal validation of β against observed 2026 tournament sensor data, with hospital emergency response time as a co-benefit metric; empirical measurement of TOM co-design outcomes in university fellowship and Fab Lab legacy contexts; comparative SCEM and circular economy performance across the full set of US FIFA 2026 host cities, examining the transit-access differential between car-dependent and transit-rich hosts; and mathematical extension of Mishra and Haldar's (2016) epidemic cascade models to formally represent hospital emergency transport as a priority-protected node within coupled urban infrastructure graphs.

Declarations

Author Contribution

S.S. conceived the study, developed the Smart Circular Event Model (SCEM) and cascade threshold analysis, conducted the literature review, and wrote the manuscript in its entirety.

References

1. Airbnb Research. (2025). *FIFA World Cup 2026 market projections: Short-term rental demand analysis*. Airbnb.
2. Alm, J., Jakobsen, S. E., & Solberg, H. A. (2016). Stadium infrastructure in host cities: From mega-event to lasting legacy. *Journal of Policy Research in Tourism Leisure and Events*, *8*(3), 277–292.
3. Boje, C., Guerriero, A., Kubicki, S., & Rezgui, Y. (2020). Towards a semantic construction digital twin: Directions for future research. *Automation in Construction*, *114*, 103179.
4. Bovy, P. H. L. (2010). On modelling and solving the mega-event transport problem: UEFA EURO 2008 in Switzerland. *Transport Reviews*, *30*(1), 101–119.
5. Davies, A., Wills, J., & Lees, L. (2023). Distributed hosting models and mega-event economic geography: Evidence from FIFA 2026 bid assessments. *Urban Studies*, *60*(4), 712–729.
6. Dolles, H., & Söderman, S. (2010). Handling the complexity of mega-sport event management: Experiences from the Beijing 2008 Olympic Games. *Asian Business & Management*, *9*(2), 209–227.
7. Ellen MacArthur Foundation. (2015). *Towards a circular economy: Business rationale for an accelerated transition*. Ellen MacArthur Foundation.

8. Electric Reliability Council of Texas. (2025). *DFW region peak demand baseline report 2025*. ERCOT.
9. FIFA. (2024, December 11). Morocco, Portugal and Spain to host FIFA World Cup 2030™. FIFA. https://www.fifa.com/en/tournaments/mens/worldcup/articles/2030-2034-host-nations-confirmed
10. FIFA. (2026). *FIFA World Cup 2026 host city infrastructure requirements*. FIFA.
11. Gold, J. R., & Gold, M. M. (2011). *Olympic cities: City agendas, planning, and the world's games* (pp. 1896–2016). Routledge.
12. Hollands, R. G. (2015). Critical interventions into the corporate smart city. *Cambridge Journal of Regions Economy and Society*, *8*(1), 61–77.
13. Kitchin, R. (2014a). *The data revolution: Big data, open data, data infrastructures and their consequences*. SAGE.
14. Kitchin, R. (2014b). The real-time city? Big data and smart urbanism. *Geojournal*, *79*(1), 1–14.
15. Laing, J., & Frost, W. (2010). How green was my festival: Exploring challenges and opportunities associated with staging green events. *International Journal of Hospitality Management*, *29*(2), 261–267.
16. Los Angeles County Metropolitan Transportation Authority (2026). LA28 Olympic and Paralympic Games: Mobility concept plan. *LA Metro*. https://www.metro.net/2028games/
17. Mair, J., & Smith, A. (2021). Moving on: New directions in event sustainability research. *International Journal of Event and Festival Management*, *12*(1), 49–63.
18. Mishra, B. K., & Haldar, K. (2016). *Mathematical model on vulnerability characterization and its impact on network epidemics*. International Journal of System Assurance Engineering and Management. Springer.
19. Mishra, B. K., Keshri, A. K., Saini, D. K., & Mishra, B. K. (2020). *COVID-19 created chaos across the globe: Three novel quarantine epidemic models*. Chaos, Solitons & Fractals. 138, Article 109928.
20. Preuss, H. (2004). *The economics of staging the Olympics: A comparison of the games 1972–2008*. Edward Elgar.
21. Reggiani, A., Nijkamp, P., & Lanzi, D. (2015). Transport resilience and vulnerability: The role of connectivity. *Transportation Research Part A*, *81*, 4–15.
22. TOM Global (2024). TOM Global movement: Programs and impact report 2024. *TOM Global*. https://www.tomglobal.org
23. Townsend, A. M. (2013). *Smart cities: Big data, civic hackers, and the quest for a new utopia*. W. W. Norton.
24. Yahoo Sports (2026, July 19). Future World Cup locations: Full list of FIFA host countries for 2030, 2034 and beyond. https://sports.yahoo.com/articles/future-world-cup-locations-full-123250652.html

Figures

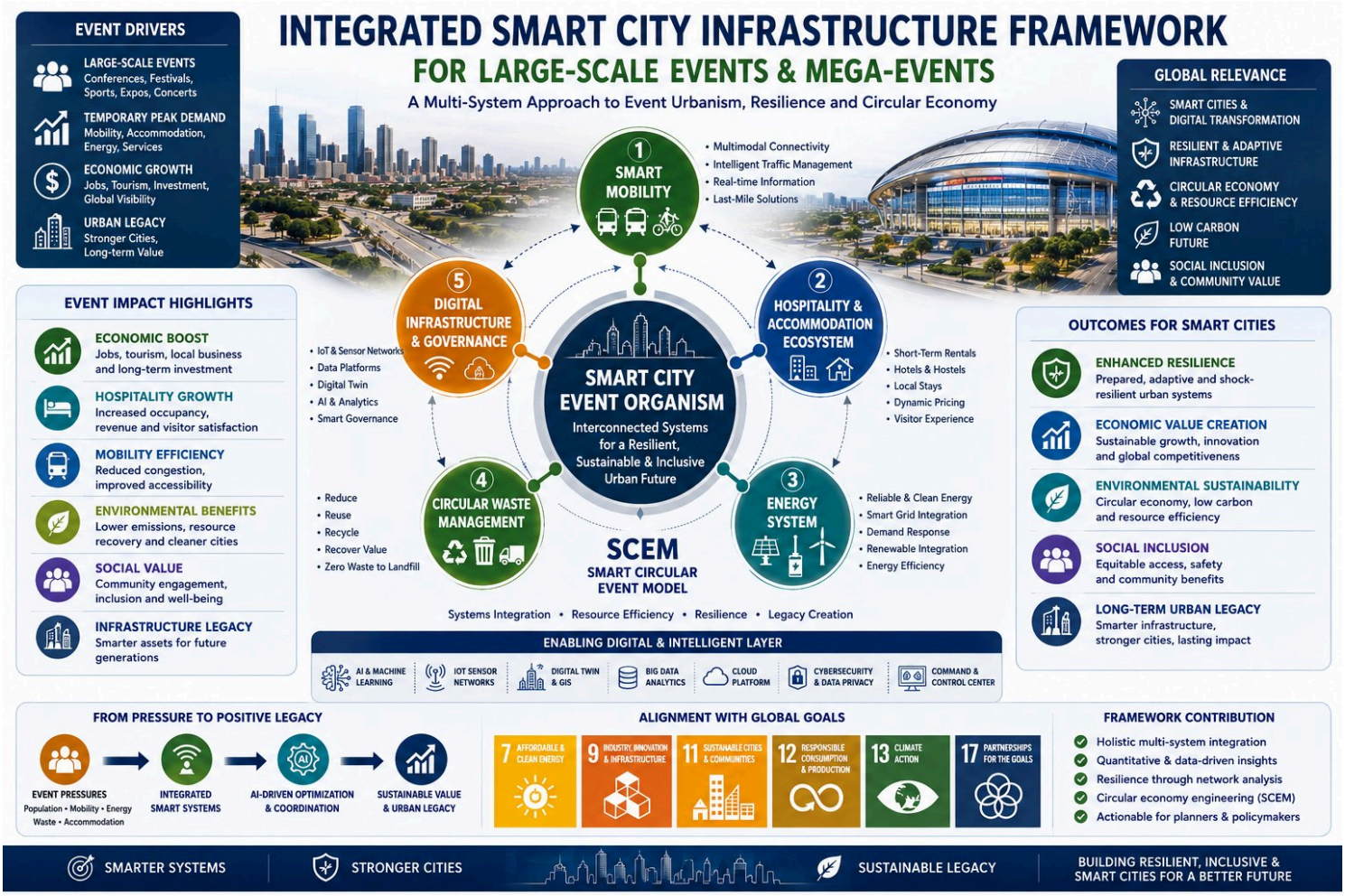


Figure 1

Integrated Smart City Infrastructure Framework — five interdependent subsystems anchored by an AI and IoT coordination layer, producing five urban legacy outcomes. Source: authors' own work.

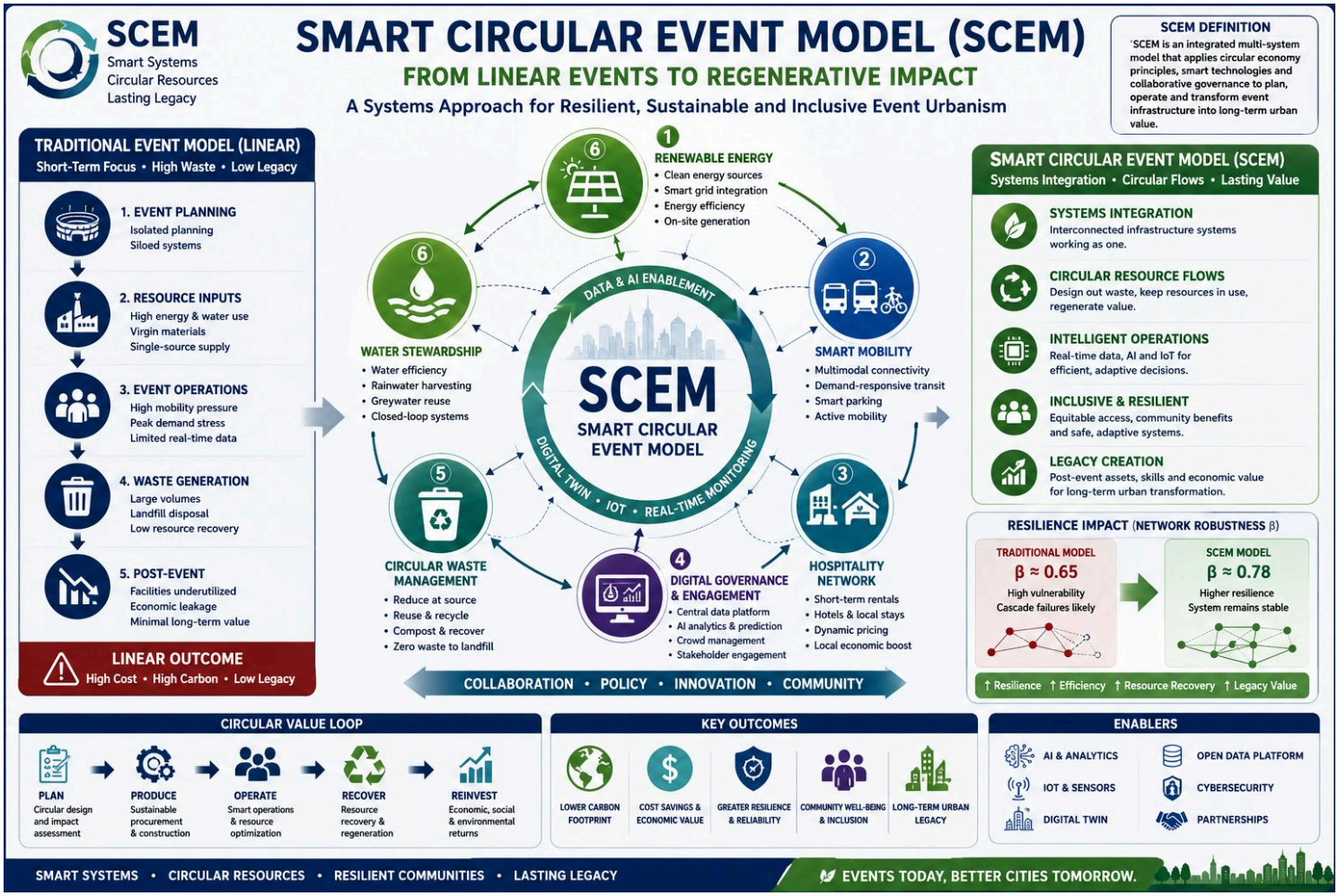


Figure 2

The Smart Circular Event Model (SCEM): from linear events to regenerative impact. Six circular systems enabled by AI, digital twin, and real-time monitoring; cascade resilience diagram β ≈ 0.65 (vulnerable) to β ≈ 0.78 (resilient). Source: authors' own work.



Figure 3

Dallas–Arlington Smart Event Corridor: integrated infrastructure from DFW Airport to AT&T Stadium. Key metrics: $32–38M short-term rental revenue; 350–400% average-daily-rate surge; 70–80% waste diversion; β ≈ 0.78. Source: authors' own work.

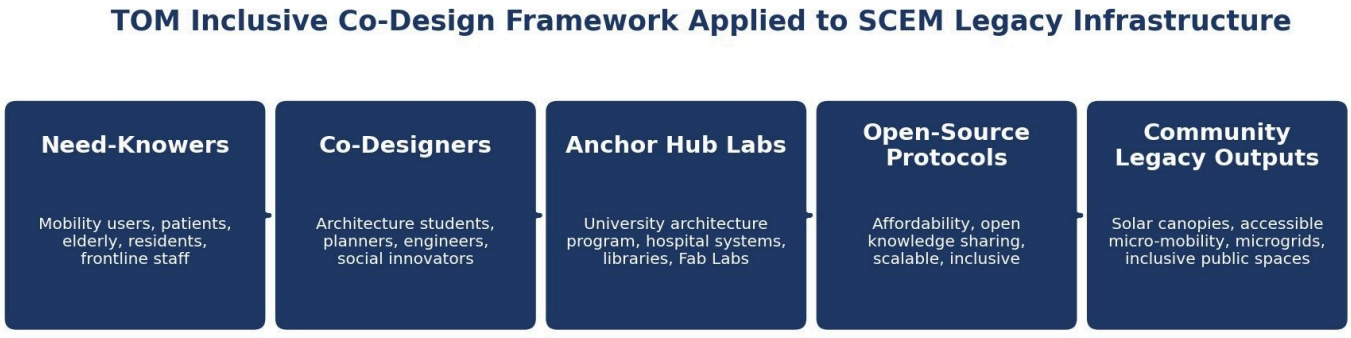


Figure 4

TOM Inclusive Co-Design Framework applied to SCEM legacy infrastructure, mapping need-knowers through co-designers and anchor hub labs to community legacy outputs. Source: authors' own work.

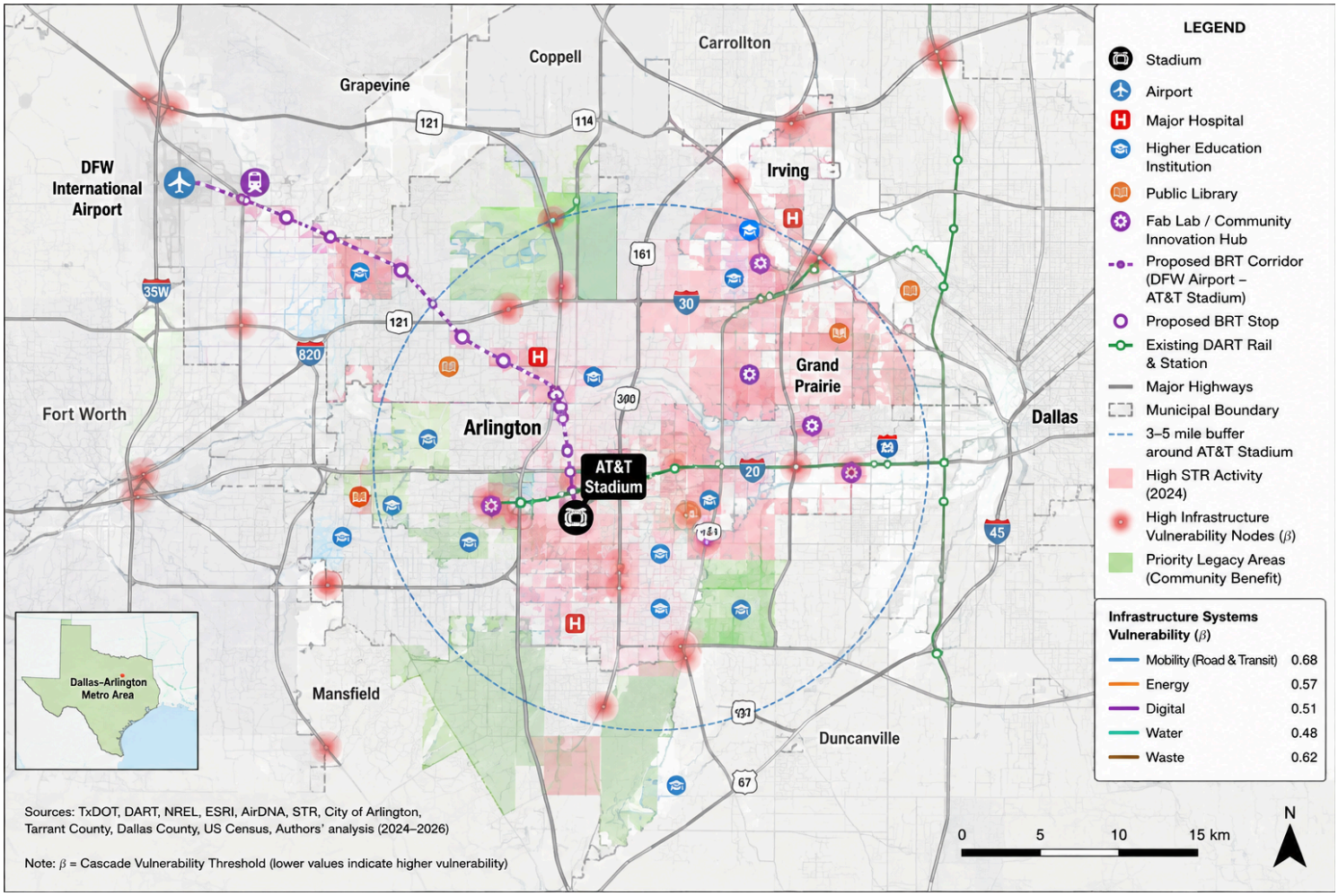


Figure 5

Dallas–Arlington spatial distribution of event infrastructure vulnerability and community legacy opportunity: stadium, airport, highway network, existing DART rail, proposed BRT corridor, hospitals, higher-education institutions, libraries, and Fab Labs, mapped against 2024 short-term rental activity, infrastructure vulnerability nodes (β), and priority legacy areas within a 3–5 mile stadium buffer. Source: TxDOT, DART, NREL, ESRI, AirDNA, STR, City of Arlington, Tarrant County, Dallas County, US Census; authors' analysis (2024–2026).