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Integrating AI & Microsimulation in GCC Urban Mobility

From video-derived traffic intelligence to calibrated scenario testing: a practical engineering framework for using AI without replacing engineering judgement.

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Executive summary

GCC cities combine rapid development, complex access patterns, high vehicle dependence in many corridors, major event demand and increasingly multimodal policy objectives. AI-assisted video analytics can accelerate the conversion of field footage into structured traffic observations, while microsimulation can test how proposed network, access, signal and demand changes interact. The value comes from integrating both inside a controlled engineering workflow—not from treating either technology as an autonomous decision-maker.

1. The integrated workflow

1. Define the decision question and study boundary before collecting data.
2. Capture fit-for-purpose traffic video and metadata, with lawful site procedures and privacy controls.
3. Use AI-assisted analytics to extract candidate counts, classifications, trajectories, speeds, queues or conflicts where technically appropriate.
4. Apply human QA/QC, exception review and reconciliation against manual samples or independent controls.
5. Convert validated observations into model inputs and calibration targets.
6. Build and calibrate the microsimulation model against observed network behaviour.
7. Test scenarios, mitigation options and sensitivities.
8. Translate model outputs into engineering decisions, drawings, phasing and authority-ready evidence.

2. Where AI adds value

Use case	Potential value	Required control
Traffic counts	Faster processing of long video periods and multiple movements	Manual sample checks; occlusion/night/weather exception handling.
Vehicle classification	Consistent categorisation at scale	Project-specific class mapping and misclassification review.
Queues / trajectories	Time-varying operational evidence	Camera geometry, field of view and tracking-quality checks.
Conflict screening	Prioritises locations/events for safety review	Not a substitute for formal RSA or collision analysis.
Data QA	Flags anomalies, missing periods and unusual patterns	Engineer determines whether anomaly is error or real behaviour.

3. Microsimulation as a decision laboratory

Microsimulation is most useful when network interactions, lane changing, signal control, closely spaced junctions, access friction, queues or multimodal interactions make simpler analytical methods insufficient. It should be calibrated to observed conditions and used to compare scenarios—not to create false precision.

Model stage	Minimum discipline
Network coding	Geometry, lane use, controls and access restrictions match the assessed scenario.
Demand	Trip matrices / turning flows reconcile to validated data and trip-generation assumptions.
Calibration	Observed volumes, queues, travel times or other relevant measures are reproduced within agreed tolerances.
Validation	Independent data/time period where feasible; document exceptions.
Scenario testing	Change only intended variables; preserve a controlled base/reference case.

Reporting	Use distributions/ranges where appropriate; explain operational cause, not only model output.

4. AI-to-model data architecture

A robust architecture separates raw evidence, machine-derived observations, validated engineering datasets and model-ready inputs. Each transformation should have a version, reviewer and reconciliation check. This prevents a model from silently inheriting detection errors or unapproved assumptions.

Layer	Example contents	Control owner
Raw evidence	Video, timestamps, camera/location metadata	Survey / data lead
Machine output	Detections, tracks, classifications, counts	Analytics pipeline
Validated dataset	Corrected counts, movement tables, queue observations	Traffic engineer / checker
Model input	OD/turning demand, vehicle mix, calibration targets	Modeller
Decision output	Scenario comparison, mitigation, residual risk	Project lead / discipline reviewer

5. GCC-specific implementation considerations

- Heat, glare, night lighting, dust, occlusion and camera mounting can affect computer-vision quality.
- Ramadan, school calendars, Friday patterns, events, tourism peaks and construction diversions can materially change observed demand.
- Rapidly changing development programmes make scenario/version control essential.
- Authority requirements should determine what evidence is acceptable for formal submission.
- Privacy, data retention and client confidentiality should be addressed before video processing or cloud transfer.

6. Governance principles

- AI assists measurement; engineers remain accountable for interpretation and recommendations.
- No automated output enters a formal model without QA status.
- Calibration targets must come from validated observations.
- Material assumptions are visible, versioned and sensitivity-tested.
- Models support decisions; they do not guarantee future operating conditions.
- Client and authority data are handled under applicable confidentiality, privacy and information-security requirements.

7. Practical KPI framework

Area	Example KPI
Data quality	Validated coverage %, sample error rate, missing interval rate
Model quality	Volume/queue/travel-time calibration measures agreed for the study
Scenario performance	Delay, queue, travel time, throughput, access performance, multimodal indicators
Delivery efficiency	Processing turnaround, rework rate, reproducibility
Governance	% datasets checked, assumptions logged, versions approved

Conclusion

The strongest use of AI and microsimulation is a closed engineering loop: observe → validate → model → test → decide → monitor. Aurelion's approach treats technology as an accelerator of evidence and scenario analysis while retaining transparent QA, authority alignment and accountable engineering judgement.

References & source controls

Use the latest edition/current authority publication at the time of each project. The references below informed this Aurelion publication; no proprietary tables, rates or copyrighted manual content are reproduced.

- **Dubai RTA Traffic Engineering System — Supporting Documents** — https://tes.rta.ae/TES/Webpages/common/InformationalLinks/SupportingDocuments.aspx
- **Transportation Research Board — Highway Capacity Manual 7 information** — https://www.trb.org/Finance/Bookstore.aspx