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SMART CITY CHALLENGE 2025
Solution idea for the city challenges

Max 3 pages
send to smartcity@taltech.ee by Nov 30, 2025

Solution Idea Title (max 5 words, no acronyms) - Decentralized Urban Material Mapping
Planned pilot project duration – 24 months
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1. Which urban challenge or problem are you planning to provide a solution to?

- Title on list: Lack of accurate enough data about building parts and materials for circular construction
- The City of Rotterdam and Tallin, summary of issue:
- Cities across Europe struggle to understand what buildings are actually made of, especially in older neighbourhoods with missing or outdated documentation. This problem directly blocks circular construction, material reuse planning, and targeted insulation renovations, all of which are essential for climate resilience.

2. The solution you are proposing

I propose a complete rethinking after several pilot projects mentioned in the problem description. A three-layer decentralized system that transforms how cities gather and validate material data:

Layer 1 — Commercial Layer: Decentralised "Scan Economy"

A gamified point-to-value system encourages citizens, residents, delivery workers, handymen, students, and building users to contribute verified micro-scans of building elements. Participants earn municipal reward points redeemable for:

- municipal fees,
- public transport,
- local shops and services,
- cultural venues, etc.

This creates a stable, city-sanctioned incentive economy that converts micro-actions into valuable circularity data. Partnered companies (construction, maintenance, housing associations) will also be able to use configured ready to install professional sensors provided by the city, receiving tax benefits for high-quality verified data contributions.

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Layer 2 — Data Gathering Layer: Structured + Flexible (JSONB-Based) Material Records

Each building element becomes an Asset Node with flexibility to allow gradual schema evolution. Data sources include:

- citizen photos (with assisted material identification and data cleaning using ML solutions),
- partner-company sensor scans (NIR, thermal, radar),
- QR/Barcode scans of installed components (where available),
- typology-based data,
- optional drone imagery or other currently established solutions.

All contributions attach to:

- building ID consists of address (via high-accuracy geolocation used in many services, like delivery apps),
- asset type (façade, roof, window segment, door, etc.),
- metadata (source, timestamp, sensor type, contributor reputation),
- confidence score.

A city admin interface defines form templates that will try to structure how flexible fields are filled and validated, which can be more evolutionary and adaptable across the pilot phase.

Layer 3 — Practical Local Data Extraction

A realistic, multi-choice data extraction model:

A. Citizen Smartphone Scanning (All Citizens, private people)

- Photo-based AI material recognition
- Assisted labeling workflow
- Optional thermal sensing (on newer phones)
- QR/Barcode scanning of exposed components.

B. Professional Universal Sensors (Partnered Companies)

Municipality provides traceable, certified devices:

- Near-infrared spectrometers (material identification)
- Thermal cameras (insulation performance)
- Portable radar (layer detection, cavity walls, concrete thickness)
- Moisture/density meters

Companies report data in exchange for tax incentives.

C. Embedded Material Codes (Where Available)

During construction, renovations or maintenance activities, workers scan manufacturer barcodes or digital product passports containing:

- material type
- composition
- insulation value

This system creates a scalable, partially validated, citizen- and industry-driven material cadastre, perfect for long term data mining. It provides:

- fine-grained building-level material maps,
- A fraction but still large set of verified materials,
- multi-layer construction details,
- confidence-ranked records for legal acceptance.

It avoids the limitations of drone-only approaches (accuracy, visibility, legal uncertainty) and instead builds a multi-source, city-wide evidence base that grows continuously.

3. Innovation and piloting of your pilot solution.

What are the best solutions available now that solve the challenge you target? (There are some solutions there for sure) How will your solution be better? What is the innovation in it?

Current solutions tested by Rotterdam (drone scans, typology cadastres, thermal imagery) provide partial insights and cannot identify hidden layers, component materials, or generate legally robust data.

Innovation:

1. Decentralised Scan Economy

Transforms millions of daily citizen interactions with buildings into structured material data — something never done at city scale.

2. Multi-sensor, multi-actor ecosystem

Combines citizens' mobile scans with professional sensor data — closing the accuracy gap.

3. Dynamic (JSONB) asset nodes

Allows cities to continuously expand the material ontology without re-engineering databases.

4. Legal trust through confidence scoring

Each datapoint carries metadata and cross-validation from:

- ML models
- citizen reputation in the platform (based on previous reports)
- partner-company sensor data
- typology priors

This makes legal/administrative acceptance feasible.

5. Startup pathway

We will form a spinoff startup during the pilot to commercialise:

- the incentive platform,
- the material mapping engine,
- the sensor integration framework.

This ensures longevity beyond the pilot phase.

What do the cities need for piloting the proposed solution?

- Access to selected neighbourhoods and building datasets
- Permission for citizen scanning incentives (municipal reward points)
- Collaboration with partner companies for sensor deployment
- Access to existing 3D models and renovation records
- Support from legal/validation teams (important for confidence scoring)

How the piloting could work?

- Select 3 neighbourhoods per city (mixed typologies)
- Deploy the mobile app to citizen volunteers
- Provide professional sensors to selected companies
- Collect material and insulation data for 6–9 months
- Cross-validate using multiple sources
- Evaluate accuracy, governance, legal acceptance
- Integrate validated results into city renovation planning tools

Please provide short information about the capabilities of the research and development proposed team. Your team should have members from TalTech as well for sure. In case you do not have them yet, which skills would you need from TalTech.

I am alone at this stage but have quite good cross functional and multi-diciplinary qualities that can be useful to form, shape and lead the work further. All skills needed are listed below:

- computer vision & AI/ML
- Material Science & NIR spectroscopy
- Data ecosystems (hopefully Databricks competence)
- Incentive gamified system design
- Built-environment circularity and renovation expertise
- software architecture & development, preferably Fullstack in pilot phase with simpler UI
- legal validation & urban governance
- Sensor engineering

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4. Expected impact of your pilot solution.

Environmental & Climate Impact

- Accelerated renovation upgrades
- Reduced renovation waste
- Better circular material recovery
- Improved accuracy of renovation planning

Citizen Impact

- New local circularity participation mechanism
- Economic benefits via municipal rewards
- Better comfort and lower energy bills
- Share value generation for citizens by citizens

City Governance Impact

- High-granularity data for climate & renovation strategies
- Legally trustworthy material cadastre
- Reduced administrative burden through semi-automated verification
- Scalable model shareable with other EU cities

As Annex, I attach even longer span of a roadmap, which would hopefully be adopted by startup for long term commercialization as an spinoff.

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Annex — Roadmap & Startup Commercialisation Plan

Phase 1 — Research & Prototype (Months 1–6)

- Build initial mobile scanning app
- Develop flexible asset node schema
- Integrate basic image-recognition model
- Configure incentive system logic
- Design professional sensor integration
- Conduct small-scale tests with 20–30 participants

Phase 2 — Pilot Execution (Months 7–18)

Rotterdam (or Tallinn)

- Select neighbourhoods
- Launch citizen reward-based scanning
- Onboard partner companies using municipal sensors
- Collect multi-source data
- Cross-validate across typologies, sensors, and human input
- Iteratively improve AI models

Research

- Material classification accuracy studies
- Legal and governance validation frameworks

Phase 3 — Evaluation & Policy Integration (Months 18–24)

- Assess accuracy and reliability
- Publish methodology and confidence scoring framework
- Integrate validated data into renovation planning tools

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- Prepare framework for Digital Building Logbooks

Parallel Track — Startup Creation

During Months 9–24:

1. Incorporate a startup as **commercialisation partner**
2. Build business models around:
    - Incentive based Economy Platform that can be used for many other services long term
    - Sensor ecosystem
    - High-confidence material cadastre services
3. Seek early customers outside the pilot cities
4. Prepare for EU-level scaling (Horizon, EIC Transition match)

Long-Term Vision (Post-Pilot)

A European "Map for Building Materials" platform enabling:

- continuous, citizen-driven building material intelligence,
- validated renovation readiness scores,
- circular material passports,
- integration with Digital Building Logbooks (DBL) across countries using open api.