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Early Lessons from Adapting the Colouring Cities Framework for Graz, Austria

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Abstract:

Building-level urban data are a key layer for sustainability analytics, city planning, cartographic representation, and urban digital twins. While open-data initiatives in Austria increasingly align with FAIR principles (Wilkinson et al., 2016), the reality of Austria's federated structure creates practical challenges for data integration and mapping at the national scale. Relevant datasets are scattered across national, regional, and municipal geoportals and catalogues. This fragmentation often leads to misaligned geometries, conflicting classifications, and different update frequencies, making it difficult to build reproducible cartographic or analytical workflows. As a result, the practical value of open urban data remains limited for researchers, practitioners, and public authorities.

This paper presents early lessons from the establishment of Colouring Austria[1], the Austrian implementation of the global Colouring Cities Research Programme[2] (CCRP), using Graz as the first pilot case. Designed to address spatial data fragmentation, the CCRP provides an open, reproducible architecture for collecting, verifying, and visualizing building-level data to support urban resilience research (Hudson, 2025). The primary objective of the pilot was to evaluate how heterogeneous Austrian urban datasets and AI-derived building attributes could be integrated into a standardized, building-level framework that supports sustainability analytics, rooftop energy assessment, and future urban digital twin applications.

The pilot implementation combined three main data sources. First, building footprints and building heights from the Federal Office of Metrology and Surveying were used as the platform's base layer. Second, Styrian land-use information was used as a proxy to derive building-type attributes and to test how locally defined categories could be mapped to the CCRP structure. Third, AI-derived roof attributes, including roof shape, roof material, and the presence of rooftop photovoltaic (PV) systems, were linked to individual building footprints using aerial imagery from Styrian geoservices and fine-tuned computer vision models. These datasets were integrated into the Colouring Austria database and web interface through source-specific ingestion scripts.

Lessons were synthesized from the implementation process itself and shaped by data ingestion challenges, semantic harmonization decisions, and operational constraints encountered during the Graz pilot. Some of these challenges were partly resolved during the pilot, while others remain open issues for transfer to other Austrian cities and for future national scaling. Based on this process, we identify five lessons for bridging the gap between reusable open-source spatial data frameworks and the realities of local urban data.

Lesson 1: The myth of the "plug-and-play" data infrastructure. Replicating the CCRP in Graz confirmed the value of a shared open architecture, while also highlighting the practical limits of framework portability. While the open-source code and the configurable setup transfer easily, deployment is still constrained by local data conditions. Because municipal datasets lack structural and geographic uniformity, automated integration is impossible; data harmonization must be custom-built for each source. In other words, the framework is reusable, but not yet an out-of-the-box solution for non-technical teams.

[1] https://github.com/colouring-cities/colouring-austria
[2] https://colouringcities.org/

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Lesson 2: The building footprint can link different kinds of data. A major strength of the CCRP model is its ability to fuse diverse datasets (e.g., official government records, AI-inferred products, and crowdsourced inputs) into a single structure. In Graz, we tested this by linking derived attributes, such as roof characteristics (including shape and material) and the presence of rooftop photovoltaic (PV) systems, to individual building footprints (Herz et al., 2025). This demonstrates that the framework does more than simply store separate datasets. It uses the building footprint as a common reference, making it possible to connect geometry, attributes, and derived indicators in a transparent and queryable way. As a result, the platform supports a more consistent building-level data infrastructure for spatial analysis and map-based exploration.

Lesson 3: Extending beyond building native indicators is still an open methodological problem. The current CCRP framework works best for indicators that are natively attached to buildings, such as roof characteristics or rooftop PV. We are currently exploring how our ongoing work on 15-minute city accessibility and 3-30-300 greenery metrics could be added to the framework. Both concepts are highly relevant to sustainability agendas and closely align with the CCRP's broader focus: the 15-minute city measures access to essential urban functions within short travel times (Moreno et al., 2021), while the 3-30-300 rule combines visible trees, neighbourhood canopy, and proximity to green space (Konijnendijk, 2022). However, unlike roof characteristics, these concepts are not directly linked to individual buildings. The challenge is therefore not simply to add new indicators, but to determine how neighbourhood- and network-based measures can be meaningfully linked back to individual building footprints without distorting their spatial meaning. This points to the need to move from a strictly building-based database towards a multi-scalar mapping framework.

Lesson 4: Local categories are hard to translate into a shared framework. Beyond technical deployment, one of the hardest tasks was matching local Austrian land-use and building-type classifications to the core categories used in the CCRP framework. These links are often not straightforward, and some categories do not align cleanly. These semantic mismatches are critical because classification choices affect how data are mapped, interpreted, and compared across cities or countries. Reapplying a shared open framework is therefore not just a technical task, but also a question of how local knowledge is translated into a common structure.

Lesson 5: An academic proof-of-concept does not automatically become an operational standard. While the Graz implementation performs well at the city scale, expanding this architecture to a national level requires more than just optimizing storage, processing, and update workflows. Municipalities may recognize the value of a shared urban data platform, but adoption depends on governance arrangements, maintenance capacity, and clarity over responsibilities. The challenge is therefore not only to make the platform technically robust, but also to move it from an academic proof-of-concept toward an operational standard that public actors are willing to maintain and trust.

Taken together, these early lessons show that Colouring Austria is not simply a technical replication exercise, but an important step in adapting a shared open framework to the realities of the Austrian urban data context. While local data structures and classifications prevent a straightforward plug-and-play deployment, the Graz pilot illustrates the value of a building-based data model for linking, organizing, and exploring urban data from different sources. Colouring Austria is therefore best understood not as a finalized database, but as an emerging and extensible reference framework. Addressing these practical and methodological challenges is a necessary step towards a more scalable and interoperable urban data infrastructure capable of supporting sustainability and resilience applications, rooftop energy assessment, and future urban digital twin development.

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