

Change – The transformative power of citizen science

Closing knowledge gaps on the building stock with citizen science: introducing the Colouring Dresden platform

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Abstract

The building sector worldwide is responsible for massive CO₂ emissions. These emissions stem from both existing and newly constructed buildings, particularly from the extraction and production of materials. Solutions include promoting circular construction, smart investments, and political measures. However, information on materials, quantities, and routes is often incomplete or inaccessible. The “Colouring Dresden” project aims to gather, explore, and communicate knowledge about buildings via the open platform “Colouring Dresden”, part of the international Colouring Cities Research Programme (CCRP). It is Germany’s first citizen science project focused on data collection and disclosure about the built environment, especially buildings. In collaboration with stakeholders, the project developed research questions, adapted the platform, prioritized data collection features, and established citizen science actions and communication channels for knowledge transfer. These actions and knowledge transfer were crucial to the project’s success. Various evaluation methods assessed their suitability in citizen science, providing insights into participant motivation, interests, and benefits for science, society, and individuals. The evaluation revealed significant differences in response quantity and data quality during data collection. The results demonstrate that citizen science projects can be effective in the built environment context, offering insights into appropriate action formats and evaluation methods. This contributes to the advancement of citizen science in Germany, enabling targeted planning of future urban citizen science projects to enhance participant motivation and collect information to reduce CO₂ emissions in the building sector.

Keywords: architecture, building knowledge, Citizen Science, Colouring Dresden, CCRP, open data, platform.

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Introduction: Why bridging building knowledge

The building stock is considered the largest economic and cultural capital. We spend up to 86,9% of our time indoors (Klepeis et al. 2001). Tenants in Germany pay up to 30% of their net income on gross rent (Lebuhn et al. 2017). On the other hand, buildings and their construction consume resources and impact the environment. The UN states that the use and construction of buildings causes 40% of annual global CO₂ emissions (United Nations Environment Programme 2020). That's why the building stock hold significant potential for climate mitigation and adaptation, exemplified by strategies such as energy-efficient renovation, conservation, reuse, and adaptations to address extreme weather- and climate-related events (European Environment Agency 2022). To achieve this objective, it is essential to create a solid knowledge base on the building stock for science, politics and society. However, essential information about the building materials used, the age of the building and its condition is often incomplete or difficult to access. Citizen Science (CS) emerges as a viable solution in this context.

The project "Colouring Dresden" aims to collect, explore and communicate knowledge about the building stock of the City of Dresden, Germany, through an open platform "Colouring Dresden" coordinated by the Leibniz Institute of Ecological Urban and Regional Development.

The platform code originated in the UK, where the first "Colouring London" platform was set up (Hudson et al. 2018) and later the global network Colouring Cities Research Programme (CCRP) was established at the Alan Turing Institute (Hecht et al. 2023). The CCRP collaboration team currently consists of academic partners from twelve countries (Hudson 2024).

In close cooperation with local stakeholders from civil society and practice (like libraries, museums, associations and school labs), administration (city of Dresden) and research (University) the following steps were worked out and openly documented on Zenodo (https://zenodo.org/communities/ioer_dresden/records?q=%22Colouring%20Dresden%22&l=list&p=1&s=10&sort=bestmatch): The project's conceptualization involved developing research questions, adapting the platform with open-source code, prioritizing data collection features, and establishing CS actions and communication channels for knowledge dissemination. The last step included identifying key audiences, creating targeted communication strategies, and utilizing various media platforms and feedback from workshops to ensure broad outreach. The target group has been identified through surveys and training and includes people interested in architecture, maps and digitisation.

Enabling participation

The CS actions and knowledge transfer proved to be key factors for the CS project. It requires a balanced exchange between coordinators and participants as both contributors and recipients of knowledge. It ensures not only a higher level of participation, but also consistency and accuracy in the data collected, making the project more reliable and trustful (Haklay 2015).

The following five opportunities existed for knowledge contribution (Figure 1A): Collecting data, supporting events, contributing of data bases, developing the code and launching a new Colouring Cities initiative.

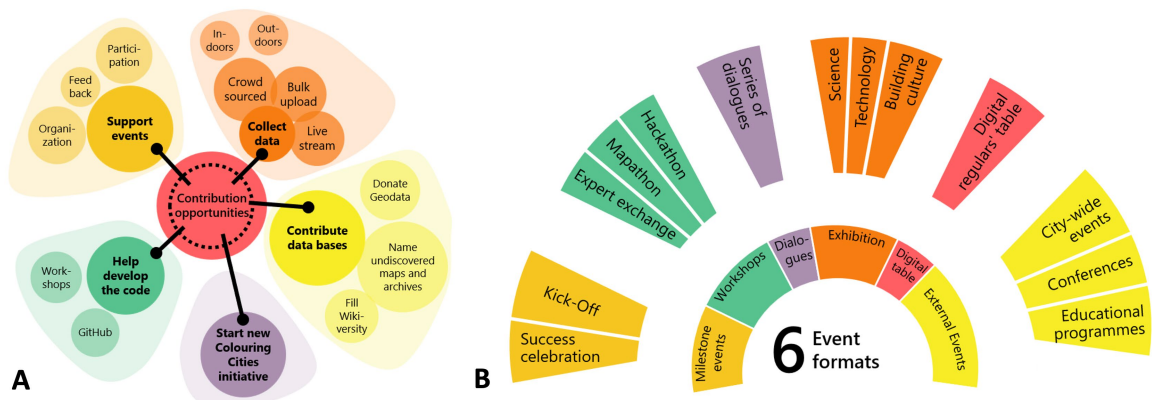


Figure 1. Facilitating Participation in Colouring Dresden. **A** contribution opportunities **B** developed and implemented event formats.

Data collection on the platform (<https://colouring.dresden.ioer.de/>) occurs in three ways: bulk upload (uploading a large amount of existing building data); live streaming and visualising of official data sets from public sources; and crowdsourcing. If data is available for a building, it appears in colour. Mapping from indoor and outdoor, individual and group training and gamification elements such as visualisation of fill levels and the dashboard were provided to facilitate data collection.

Supporting events promoted the engagement by fostering participation and offering valuable feedback. External partners were also invited to co-organize events, which resulted in six event formats (Fig. 1B): milestone events, workshops, dialogues, exhibitions, digital regulars table, and external events. Each format targeted distinct audience demographics by varying venues, schedules, levels of interaction, and other parameters.

CSists have also been able to engage with the open source code at events or at home. The code is available on GitHub (<https://github.com/colouring-cities/colouring-dresden>) and enables editing and providing feedback by the CSists.

Contributions to the databases can be made directly, through entries in Wikiversity (https://de.wikiversity.org/wiki/Projekt:Colouring_Dresden), the CCRP's open manual at GitHub, or indirectly through suggestions of undiscovered projects, maps or archives.

Starting a new Colouring Cities initiative is the opportunity for institutions to start a complete new local CS initiative in their city. Some cities have already expressed their interest and exploratory work is underway to set up such platforms.

Evaluating participation

Evaluation can identify improvements for outreach and communication strategies. Various qualitative and quantitative methods, timed and lasting differently during the project, offer insights into participants' motivations, interests, and societal benefits.

Significant differences were found in the number of contributions according to complexity and geographical distribution. In the initial 29 weeks (from Launch on the 06.03.2023 till funding end 01.10.2023) following the platform's launch, 99 registered users collectively made 21,599 edits, averaging 720 edits per week and 103 edits per day. It is apparent that some features are more attractive or easier to map than others (Fig. 2A). More edits were recorded in the city centre of Dresden than in the suburbs (Fig. 2B), which is a typical phenomenon in crowdsourcing projects such as OpenStreetMap (Hecht et al. 2013). Observations indicated that the action formats led to increased mapping activity on the platform. The effectiveness of communication channels was higher in the first half of the project compared to the second. Further research into this is underway.

The evaluation's second finding focused on participants' motivations during events. A questionnaire at ten different events showed that the acquiring knowledge emerged as the predominant motivation (21%), followed by supporting the project (18%). Personal development, participation in scientific endeavours, networking opportunities, and meeting new individuals were equally cited motivations (12% each). Conversely, addressing local issues in Dresden represented the least prevalent motivation, accounting for 10%.

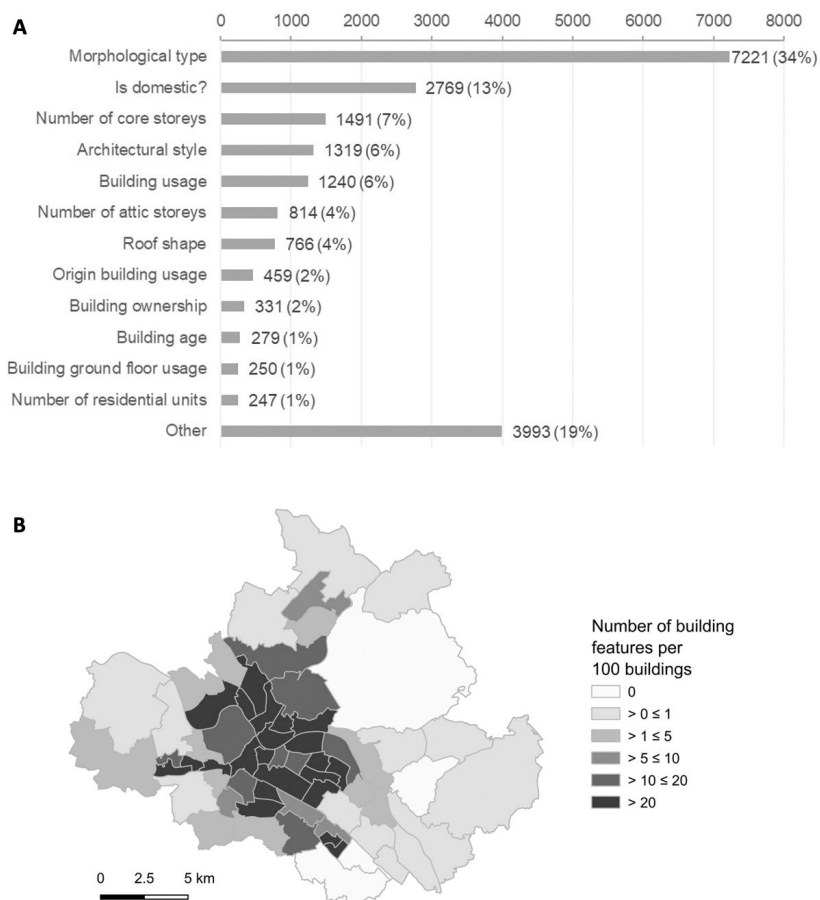


Figure 2. Mapping activities from 06.03.2023 to 01.10.2023 showing: **A** the total number of building features and **B** the spatial pattern of edits.

Discussion and Conclusion

Several key areas can be identified for future research. Firstly, there is potential for advances in the prediction of building characteristics and types through artificial intelligence (AI). Secondly, comparative analysis of data quality between citizen science, official sources and AI-generated data offers valuable insights. In addition, exploration of critical data studies and their applicability as governance tools is essential.

Current discussions show a potential government involvement in managing the Colouring Dresden project. Furthermore, there was interest in the demographic categorization of participants, the utilization of collected data, and distinguishing the Colouring Dresden features from OpenStreetMap (OSM). In addition, the discussion showed that there is a need to address how to deal with mixed uses within a building.

The project shows in general that CS can be successful in context of built environment research in terms of user activation and participation, data collection, but also the learning effects for the participants and respectful, sustainable cooperative collaboration. They also offer insights into suitable action formats and evaluation methods. This contributes to the further development of CS in Germany and enables the targeted planning of actions in future urban CS projects to increase the motivation of participants and to collect information on reducing CO₂ emissions in the building sector.

References

- European Environment Agency (2022) Building renovation – Where circular economy and climate meet. Publications Office of the European Union. <https://doi.org/10.2800/416573>
- Frantz D, Schug F, Wiedenhofer D, Baumgart A, Virág D, Cooper S, Gómez-Medina C, Lehmann F, Udelhoven T, Van Der Linden S, Hostert P, Haberl H (2023) Unveiling patterns in human dominated landscapes through mapping the mass of US built structures. *Nature Communications* 14: 8014. <https://doi.org/10.1038/s41467-023-43755-5>
- Haklay M (2015) Citizen Science and Policy: A European Perspective. The Woodrow Wilson Center, Washington, 76pp. Available from: https://www.wilsoncenter.org/sites/default/files/media/documents/publication/Citizen_Science_Policy_European_Perspective_Haklay.pdf.
- Hecht R, Kunze C, Hahmann S (2013) Measuring Completeness of Building Footprints in OpenStreetMap over Space and Time. *ISPRS International Journal of Geo-Information* 2: 1066–1091. <https://doi.org/10.3390/ijgi2041066>
- Hecht R, Danke T, Herold H, Hudson P, Munke M, Rieche T (2023) Colouring Cities: A Citizen Science Platform for Knowledge Production on the Building Stock - Potentials for Urban and Architectural History. In: Münster S, Pattee A, Kröber C, Niebling F (Eds), *Research and Education in Urban History in the Age of Digital Libraries*. Communications in Computer and Information Science. Springer Nature Switzerland, Cham, 145–164. https://doi.org/10.1007/978-3-031-38871-2_9
- Hudson P (2024) Colouring London and the Colouring Cities Open Manual. Wiki. Available from: <https://github.com/colouring-cities/manual/wiki/>.

- Klepeis NE, Nelson WC, Ott WR, Robinson JP, Tsang AM, Switzer P, Behar JV, Hern SC, Engelmann WH (2001) The National Human Activity Pattern Survey (NHAPS): a resource for assessing exposure to environmental pollutants. *Journal of Exposure Science & Environmental Epidemiology* 11: 231–252. <https://doi.org/10.1038/sj.jea.7500165>
- Lebuhn DH, Holm DA, Junker S, Neitzel K (2017) „Sozialer Wohnversorgungsbedarf“. Available from: https://www.boeckler.de/pdf_fof/99313.pdf.
- United Nations Environment Programme (2020) 2020 GLOBAL STATUS REPORT FOR BUILDINGS AND CONSTRUCTION. Nairobi Available from: https://globalabc.org/sites/default/files/2021-03/Buildings-GSR-2020_Report_24-03-21_0.pdf.