Data and material passports

A material passport is used to document the amounts, quality, accessibility and reusability of construction and demolition waste for reuse or recycling. This Replication Package describes the CityLoops definition of a material passport as well as different methods for gathering data of materials, products, or components in order to create a material passport.

Material passports share the same objective, namely quantifying and qualifying the materials on site. However, they differ in the level of detail and number of aspects taken into account. The top five requirements for a material passport in CityLoops are:

- A bill of materials with quantities, material composition, and location of the materials on site.
- Inspection and maintenance history of the materials.
- Technical lifetime expectancy of materials.
- 'End of life options' of the materials.
- A uniform system for data storage for structured output.

The Replication Package describes and compares four methods used in different demo-actions to gather and store data on CDW materials for reuse or recycling. The data in all demo-actions was stored in local databanks or Excel-sheets and used to document the quality and reusability of the materials, thus functioning as material passports. Two cities also developed digital marketplaces, which can use this type of data for materials classification (for more information, visit the Replication Package 'Material banks and marketplaces').

Recommendations from lessons learnt

Four cities in CityLoops tested different methods of gathering data on materials for reuse or recycling purposes. Based on their experience, we have prepared some generic and method-specific recommendations that can help cities select and using efficiently the right methods for their construction projects:

- It is valuable to have a standard procedure in place for mapping and documenting the reusability/recyclability of materials in demolition projects.
- The pre-demolition audit should be done well in advance of the demolition and in cooperation with various stakeholders, so that the reusable or recyclable materials and elements are identified and included in the tendering of the selective demolition and they can be connected to the design processes.
- For all data gathering methods a more advanced resource mapping system is needed, e.g., a pre-demolition audit reporting software program to be used to report and archive audit findings.
- In the demo actions local systems was adapted and used for data storage, but integration between the database storing information about the materials and a digital marketplace can be difficult. Thus, some cities have moved on to external systems which can handle this.

- It is useful with a market-oriented material passport where the bidding and tender phase with external partners can include and work with the information about the secondary materials.
- It may not be possible to find or describe all the wanted information for a Material Passport. Especially the expected lifetime and the estimated value can be a challenge.
- ***The 3D visualization tool (digital twin)*** is useful for large urban development projects, but also suitable for 3D modelling of buildings. It can be used for gathering data on masses and materials, and plan how new buildings can be made with on-site resources. It is efficient to interpret complex data, and visualization help making decisions based on real data. Data for the 3D visualization came from e.g., excel sheets, traffic API and Circulus. There were many different types of data, which were entered manually. This process can be optimized if it becomes possible to connect data between different systems.
- ***The drone scan*** can produce useful data for the pre-demolition audit and planning of the demolition work. Volumetric measurements based on 3D imaging can be a useful tool for contractors, building owners, consultants, and designers. The drone scan is useful and quick for mapping the materials in a building or construction site, but you need humans to inspect the results. The scan cannot recognize materials, but from photos you can calculate masses, number of windows, bitumen on roof etc. If you have the proper equipment, you can do both outside and inside scanning.
- ***The road scan with cameras and sensors on vans*** can collect data on the amount and quality of materials available from the road. It can provide additional insights in the status of road materials, but developments are still needed to interpret the data and automate data storage. It is especially useful for asphalt roads, as it cannot assess the quality of concrete pavers yet – in this case a drone may be a better option. It was not possible to assess data on lifetime expectancy and re-use options of materials, products, and components from the road scan, but a visual inspection on-site can provide this knowledge.
- ***The simple excel sheet*** is an easy way to get started with screening buildings and gathering data on elements or materials for reuse and recycling. You visit the building/construction site and enter data on materials for reuse/recycling in an excel sheet with photos. Afterwards you identify which materials are relevant for reuse or recycling, and whether you need to gather more information about them or test them for hazardous substances. The more different stakeholders you involve in the tour of the area, e.g., environmental advisors, architects, contractors and engineers, the more ideas you will get on the reusability of elements and materials.

CityLoops instruments

- **Material passport definition:** Five requirements for a material passport were developed in the CityLoops report *"Construction material passports and databanks",* which also describes different approaches to material passports and dives into how a material passport can be applied to a circular road renovation project.
  The report with the definition of a material passport is available here.

https://3.basecamp.com/4291695/buckets/14002130/uploads/5972238172

- **Procedure for CDW to obtain a Material Passport:** Roskilde has developed a simple five-step procedure for demolition materials to obtain a material passport and be approved for use in future construction.
  This procedure can be found in Roskilde's demonstration report extract on data and material passports, available here.
  https://3.basecamp.com/4291695/buckets/14002130/uploads/6044067235
- **Replication report for 3D visualization solutions (Digital Twin):** The digital twin of the city has proven to be a useful tool for urban planners, policymakers, and researchers alike. It holds mass quality data from demonstration site, material data from buildings on demonstration sites and pilot buildings, visualisation of transport, infrastructure and emission data and identification of loose sediments and potential sea level rise at the demonstration site. This report describes the software used, technical and physical requirements and equipment as well as the gathering and visualization of data. In order to replicate Bodø's activities, it is not necessary to be in possession of the tools mentioned here. However, it is necessary to use tools that can geographically place data. In extension of this, the replicator should be in possession of a software that can manage data e.g., Excel.
  Here you will find a short introduction to the 3D visualization
  https://3.basecamp.com/4291695/buckets/14002130/uploads/6044304316
- **Blueprint for drone scan and 3D modelling tool:** The use of 3D modelling tool to monitor demolition waste flows can be a cost-effective alternative in evaluating the amounts of material flows on-site when compared to traditional methods, e.g., tachymeter. The data capturing process with drones on the demolition sites demonstrated in the project takes an average less than an hour.
  This instrument is available here.
  https://3.basecamp.com/4291695/buckets/14002130/uploads/6342967296
- **Guide for replication of road scans and data storage:** Road scans can provide additional insights in the status of road materials, but developments are still needed to interpret the data and automate data storage. The LiDaR system with high resolution imaging seems to be able to provide data that is closer to the traditional process of a visual inspection on site. It was not possible to assess data on lifetime expectancy and re-use options of materials, products, and components from the street scan.
  A guide for replication of the road scans and data storage can be found in the report *"Collecting and storing data in a circular road renovation process"* available here.
  https://3.basecamp.com/4291695/buckets/14002130/uploads/5972247265

CityLoops demonstration experiences

- **Bodø - 3D visualization in a digital twin in:** Bodø mapped the masses and structures of the old airport and entered the data on quantity, quality and reusability in a digital twin. The digital twin technology delivers 3D visualization solutions for designing a new part of the city using existing structures and resources. This is a great demonstration action to replicate for other cities that are facing large urban development projects. Here you can

read about experiences from using the digital tools in relation to the demolition of the military airport, mapping and visualizing masses and structures.
Read about Bodø's experience here.
https://3.basecamp.com/4291695/buckets/14002130/uploads/6047933864

- **Mikkeli - Drone scan of buildings and construction site:** Mikkeli scanned buildings and demolition site with drones using a 3D modelling tool for tracking the flows of on-site CDW. The scans provided 3D models and digital imagery from each of the monitoring session done onsite during the demolition process.
  Read about Mikkeli's experience here.
  https://3.basecamp.com/4291695/buckets/14002130/uploads/6044265047
  More information of Mikkeli's demonstration results in using the drone scan can be found here.
  https://3.basecamp.com/4291695/buckets/14002130/uploads/5717423204
- **Apeldoorn - Road scan with cameras on vans:** Apeldoorn collected data on the amount and quality of materials available from Grieffiersveld road through scans with cameras and sensors mounted on vans, using two different road scanning processes: One scan with an IDS RIS Hi-Pave ground penetrating radar system at the back and a gamma spectrometer at the front of the van and another scan where Light Detection and Ranging (LiDaR) data and panoramic high resolution images were collected. Their GBI databank was adapted to store the data.
  Read about Apeldoorn's experience here.
  https://3.basecamp.com/4291695/buckets/14002130/uploads/6044121222
- **Roskilde - Simple data registration in excel-sheets:** Roskilde conducted a manual resource inspection of the buildings to be partly demolished, identifying materials for reuse or recycling. A simple digital databank and material passport was then created for selected materials from the demolished buildings, consisting of an Excel sheet for each material, describing its lifespan, what kind of testing it has to go through, and where it could end up in future uses. This is a very simple, cheap and low-key solution that is easy to replicate. However, the data would need to be uploaded digitally if the materials was to be added to a marketplace. Roskilde has afterwards moved on to using the Upcycling Forum databank and marketplace.
  Read about Roskilde's experience here.
  https://3.basecamp.com/4291695/buckets/14002130/uploads/6044067235