

Materials Passports: Providing Insights in the Circularity of Materials, Products and Systems

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The Challenge

Manufacturers and their customers are looking for reliable and convenient data on product designs, pathways, and composition in order to determine their potential for a Circular Economy (CE), including; optimal productivity, recycling vs. downcycling, and optimising residual value of materials. Due to the CE, demand is growing for ways to put the recovery potential of materials, products and systems into practice. Existing tools only partially meet those needs because they focus more on measuring and reducing negative environmental impacts rather than increasing positive value creation.

The Solution

Materials Passports are a tool to put the CE into practice. MPs, as well as an accompanying software system, are being developed in the EU Horizon 2020 Buildings as Material Banks (BAMB)¹ project, based on the concept described in the publication 'Resource Re-Pletion.' (Hansen, Braungart, Mulhall, 2012)², using the term Nutrient Certificates:

"Nutrient Certificates are sets of data describing defined characteristics of materials in products that give them value for recovery and reuse. The certificates are a marketplace mechanism to encourage product designs, material recovery systems, and chain of possession partnerships that improve the quality, value, and security of supply for materials so they can be reused in continuous loops or closed loops or beneficially returned to biological systems. This is done by adding a new value dimension to materials quality. This new dimension is based on the suitability of materials for recovery and reuse as resources in other products and processes."

The scope of passports is on the level of materials, products and systems. This means that a single passport would refer to a material, product or system. For a material it can define its value for recovery. For products and systems it can define general characteristics that make them valuable for recovery such as their design for disassembly, but it can also describe specifics about a single product or system in its application. For instance, the connection of a product to a building is essential to understand its value for recovery.

For brevity this group of materials, products and systems will be referred to simply as 'products' throughout this paper. This scope of passports is in line with the 2013 call for passports on a product level by the European Resource Efficiency Platform (EREP 2013), also stated in the EREP Manifesto & Policy Recommendations (EREP 2012).

¹ BAMB, Buildings As Material Banks, is a EU Horizon 2020 project enabling the shift to a circular building sector. The project is carried out by a consortium consisting of the following 16 partners: IBGE-BIM, EPEA Nederland B.V., VITO, BRE, ZUYD, IBM, VUB, Ronneby Kommun, Sundahus I Linkoping AB, TUM, Universiteit Twente, UMINHO, Sarajevo Green Design Foundation, DS-ABT, BAM and Aurubis Bulgaria AD.

² Resource Re-Pletion. Role Of Buildings. Introducing Nutrient Certificates A.K.A Materials Passports As A Counterpart To Emissions Trading Schemes, Katja Hansen, Michael Braungart, Douglas Mulhall, The Springer Encyclopedia of Sustainability Science and Technology Meyers, Robert A. (Ed.) July 2012

Methodology of development

Within BAMB the methodology followed to develop Materials Passports is split up into two main phases. The first of which is the user requirements gathering phase. The second phase is the parallel development of the conceptual framework for Materials Passports and its corresponding software system: The Materials Passports Platform, or MPP. The development of the conceptual framework is iterative in nature and is based on the results of the first phase.

For the user requirements gathering phase users were selected from various stakeholder groups for whom MPs are relevant. They were involved in a brainstorm session to provide input to the discussion of the user requirements. After analysis the results were translated into a base set of user requirements, and used in the next phase.

In the next phase the user requirements were refined by several means. Iteratively use scenario's, use narratives, use cases, supplemental documents and the description of data types which should be integrated on the software system were developed and refined. Additionally, passport development by EPEA before the start of the BAMB project were taken into account as input as well. All of this resulted in a collective understanding of the concept and function of Materials Passports, while providing practical input for the development of the software system.

Next steps are to develop the software system and then start testing it by generating passports for actual products. During the entire duration of the project (which started September 2015 and will run until March 2019), the conceptual framework will continuously be developed. Experiences will be reflected upon and lessons learned will be taken up in the conceptual framework and may result in configurations of the software system.

Standardization and existing tools

There are several existing tools with thematic relations to Materials Passports. These include tools aimed at measurement and declaration of impacts on environmental indicators such as Life Cycle Analysis (LCA) and Environmental Product Declarations (EPD). Tools aimed at inventorying compositional data such as Bills of Materials and Bills of Substances. Tools detailing technical and static properties such as Materials Safety Data Sheets (MSDS) and Technical Data Sheets (TDS) and tools which share goals and mechanisms for action with Materials Passports, exemplified in the 'Building a circular future' report (3XN, 2016), which gives a detailed and accurate account of passports.

Passports have the potential to incorporate existing mechanisms such as TDS, MSDS, EPD, Bill of Materials, Bill of Substances, et cetera where relevant as support for circularity claims. This avoids reproducing data and reinventing the wheel, which are key concerns of product manufacturers and their suppliers, who will play an important part in populating passports. At least in the early stages.

There are important differences between Materials Passports and the other categories of tools both in their respective goals and in their modes of action. Materials Passports are about realising the full circular potential of products. This can be supported by measurements of impacts, which includes beneficial impacts of products in their application such as improved air quality. Measurements of negative impacts however is not a goal in itself for passports. Similarly, compositional data may be used to support claims and information about the circular potential of products, but passports are not limited to compositional data on products or buildings. This is important as the ingredients list analogy is easy to make. Compositional data is relevant to understand the circular potential of products, but it may not be sufficient.

Illustrative of the distinctiveness of passports is that they hold dynamic data. Data which can be dependent on the spatial or temporal context products are used in. As mentioned earlier in this paper the way a product is connected to a building is vital to its circular potential. A reversible connection may be preferable to the product being glued in place with no chance of uncontaminated recovery. It is also important to know whether maintenance has taken place and whether parts were replaced, as this potentially changes the materials and products that are available at time of recovery, and their value for recovery. As passports have the ambition to inspire action related to the CE these are important questions that passports should be able to answer, and which are generally not answered by the traditional tools mentioned.

Building information modelling (BIM) is an important investigation in the BAMB project. For Materials Passports to work it is important that there is alignment between the data that can sit in the Materials Passports Platform, and the data available in BIM and BIM-objects. Part of the complexity is the current lack of standardization of BIM. For passports it is important that for instance BIM-objects can be connected to the relevant products. The other way around, viewing passport data in BIM, sounds appealing, but as 3XN states *"...it is recommended that only information identifying the unique element be entered into the model, as that would allow the model to operate faster. As long as all elements of the structure are uniquely identifiable in the model, all other information on the unique characteristics of the structural elements can be kept in a separate database, as long as there is access to this information."* (3XN, 2016). To clarify, the 'model' referred to is the BIM or the Virtual Design and Construction (VDC) model. The "Database" refers to the Materials Passport Database.

Transparency and secrecy

Two topics of high importance for the development of Materials Passports are those of transparency and secrecy. Materials Passports are under development as of the time of writing this paper. Considerations about these topics include:

Information stored for Materials Passports should have a purpose. That means that it should be accessible by those parties capable of connecting it to an action. Having information stored which cannot be accessed due to secrecy is not beneficial for this.

In certain cases it is not realistic that important information will be made available transparently, even though there may be a general trend towards more knowledge and transparency in the years to come. This is for instance currently the case in the polymer industry, where compositional information is regarded as competitive knowledge.

There are cases where detailed information is important, but not necessary to be fully transparent to the public, as long as an evaluation of the information can be presented transparently. This is for instance the case for compositional information: The end user might not be interested in the full details of what is in a product, but more in the fact that a product contains no harmful substances or beneficially cleans the air. A building manager in turn might be more interested in for instance the next pathway of the product.

Third party knowledge trustees will have an important role in cases where detailed information is required, but cannot, will not, or does not have to be made public. Third party knowledge trustees will draw conclusions based on evaluations of detailed knowledge and make these conclusions available in Materials Passports.

Materials Passports as an innovation mechanism

Materials Passports have the potential to be used by many types of stakeholder throughout the value chain of a building, and through that deliver a multitude of value propositions. One of these is their ability to influence innovation and design of products. Having a pragmatic approach to not only operationalise circular potential, but to put it into practice, they provide incentives for innovation in more than one way:

- By providing guidance. The passport is not normative first and foremost like a certificate would be. Having a passport does not necessarily make the product good for the Circular Economy. It is about what is in the passport. If the product indeed has good circular potential the passport is an enabler to fulfil that potential. By providing the opportunity for a producer to deliver essential information about its products it will become clear to that producer which information is still missing, or which aspects of the product are not up to par. This potential is also identified by Desso in the 'Towards the Circular Economy report (WEF, 2012)'.
- Materials Passports provide an opportunity for manufacturers or suppliers to stand out from the crowd. Either through transparency on their respective products, or by showcasing well thought out products with good circular potential.
- Traditionally some industries are less transparent and/or knowledgeable about the actual substances used in their products. Developing a better understanding of one's products is an

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important step in innovation before appropriate optimisation can occur. One mechanism through which this can occur is by requesting passports in tendering procedures.

- Materials Passports provide a driving force for novel ownership and business models. Reversibly designed products and systems are especially interesting for leasing constructions for example.

Conclusion

Materials Passports aim to support the CE and fill a marketplace gap with reliable information for diverse users on the composition, pathways and circular designs of products. By doing so, they provide a mechanism for innovation.

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