BIM for pre-demolition and refurbishment inventories and waste information management

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Abstract

The presented BIM-SD tool is a software tool supporting the user in the pre-demolition audit and C&DW assessment. Its main objective is to support the collection and management of information on the existing elements and materials in a building to be demolished, the decision making around the optimal demolition sequence and the management of the subsequent waste streams. Maximizing the recovery rate from buildings will be fostered thanks to the visibility of the present materials in the pre-demolition stage. More in detail, the BIM-SD tool will ease calculations of inventory experts and/or demolition experts, which nowadays are principally done by hand (or supported by basic tools such as calculation sheets), potentially improving reliability of calculation, facilitating the traceability of materials and quickening the evaluation of alternative demolition/recovery options.

It is expected that the tool can assist both demolition contractors for improving the production of the waste audits which they already perform; and also building owners (and the team commissioned for the design of the corresponding demolition works) in producing reliable waste audits together with projects. Moreover, distribution of the original BIM-model or of the inventoried BIM-model from the building owner to e.g. demolition contractors participating in a tender could happen.

Keywords: BIM, demolition, waste, materials, building.

Introduction

1. Gaps at the pre-demolition stage

A waste inventory performed prior to a demolition (or refurbishment) provides relevant information about the building and the contained C&DW. Qualities and quantities of the materials present in the building that will be set free along the process are identified, together with information about the location and form of the material. The identification includes information on the hazardousness of the materials (both due to the nature of the material or contaminations occurred during the use of the building).

By adding to this inventory recommendations on how these waste materials can be managed (reuse, recycling and other forms of material recovery, energy recovery or disposal), depending on legal requirements, (local) economics (e.g. value of recycled materials) and location (available (regional) infrastructure), a waste audit is produced. This will make it possible to generate a waste management plan (times, tasks & resources) and the corresponding budget.

Nowadays waste audits are seldom available, do not provide enough detail or are claimed to be unreliable [HISER, 2015]. Moreover, in most cases audits are prepared by non-experts or by non-independent professionals. However, in all countries, most of demolition contractors make their own pre-demolition audit (or have it done by a professional), principally to
calculate the price of the demolition works. This audit is typically of internal use of the demolition company only.

The lack of digital representation of the buildings to-be demolished and lack of information on the present materials hampers the decision on the optimal demolition process, the waste streams produced and corresponding treatment processes. Lack of computerized tools supporting the study leads to studies principally done by hand or supported by basic tools such as calculation sheets (e.g. Excel).

In a more general framework, there is a need to improve the collection of data and statistics for monitoring C&DW by authorities. Nowadays, the low quality of the available data is a main barrier in estimating the actual quantities of generated C&DW and recycling and recovering rates. As a result, there are difficulties in a valid comparison between Member States and the establishment of targets and better policies and practices. Improved pre-demolition audits will provide more visibility and accuracy to the forecast of waste, notwithstanding the fact that verification on the actual generation of waste and subsequent treatment will be required for a good data collection.

2. Building information modelling

Traditional building design and, by extension, demolition projects have been largely reliant upon two-dimensional technical drawings (plans, elevations, sections, etc.). This is however quickly evolving and Building Information Modelling (BIM) is taking over.

BIM is a digital representation of physical and functional characteristics of a facility (Figure 1). BIM changes the paradigm going from drawings to digital models which extend beyond 3D. These BIM models are based on entities which include both (3D) geometrical and semantical information like materials, manufactures’ detail, construction details, etc. A BIM is a shared knowledge resource for information about a facility forming a reliable basis for decisions during its life-cycle; defined as existing from earliest conception to demolition.

Some advantages of BIM are: improved visualization; improved productivity due to easy retrieval of information; increased coordination of construction documents; embedding and linking of vital information such as vendors for specific materials, location of details and quantities required for estimation and tendering; increased speed of delivery; and reduced costs.

In the context of refurbishment or demolition works, use of BIM is still limited, as these buildings were constructed in the pre-BIM era and, as such, lack a BIM representation. Considering however the explained potential of BIM, together with the quick spread of new technologies allowing an economical interesting and easy generation of a BIM model of a building lacking such representation, the tool explained in the present document has been developed.

Description of the SD-BIM tool

The main objective of the tool is to support the collection and management of information on the elements and materials available in a building to-be demolished and the decision making around the optimal demolition sequence and the management of the subsequent waste streams. Maximizing the recovery rate from buildings will be fostered thanks to the visibility of the present materials in the pre-demolition stage.

The BIM-SD tool will ease calculations of inventory experts and/or demolition experts, which nowadays are principally done by hand (or supported by basic tools such as calculation sheets as e.g. Excel), potentially:

- improving reliability of calculation
- facilitating the traceability of materials
- quickening the evaluation of alternative demolition/recovery options (by running the tool with different solutions).

The BIM portable editor particularly supports the pre-demolition inventory process. Using this tool, the user will identify the products, construction systems and materials present in the building using a database linked to the tool, which will provide relevant information for the completion of the building inventory, such as: deconstruction processes usable for each element (e.g. disassembly); definition of materials present and assignation of codes from the European List of Waste; or formulas for the calculation of weight and volume of each of these materials (with the corresponding list of relevant parameters). Additionally, depending on the specific element, the collection of auxiliary information (typically some dimensions, such as partition wall thicknesses) will be required from the user. Moreover, the user will have the opportunity of editing (default and rest of) values for a more accurate calculation. Based on the identification and assignation of elements, a weight and volume calculation of each expected waste material will be done by the tool, providing automated and reliable results. This inventory can be done onsite, as the tool has been designed for portable devices. Furthermore, could be edited/completed at the office afterwards if preferred by the user.

In this document, an overview of the BIM editor functionalities and its use is done providing, screenshots and explanations. Aspects reviewed are e.g.: how to check on the progress of the inventory process and elements pending to be inventoried, other visualizing options of the building, how to inventory elements (both with a BIM entity or without), how to spread properties from one inventoried element to others to speed up the process, or how to add estimations on hidden elements such as cables, pipes and foundations.

As a second task after the inventory, a waste assessment can be developed by means of the second part of the HISER BIM-SD tool, i.e. the Smart BIM-SD Analyser.

**Processes the tool is addressed to**

The tool developed in HISER focuses on two pre-demolition studies: the waste inventory (1) and the waste audit (2).

**Inventoring onsite: Portable editor**

A tool allowing an onsite waste inventory process has been developed. The user will identify the products, construction systems and materials present in the building with the guidance of the tool. Based on this assignation, a calculation of the expected waste materials will be done by the tool, providing automated and reliable results.

**Planning the waste management: Smart BIM-SD Analyser**

For the generation of the waste audit, the second tool supports the desk study of the actual waste streams that will be produced depending on the (disassembly, removal, and demolition) processes planned for the different elements in the building. Subsequently, corresponding reuse, recycling, energy recovery or disposal options can be established. For a successful waste audit at least some main assumptions on the demolition process must be considered, as the waste streams that are actually released depend on the demolition process itself. The user will define groups of elements that are released from the building in each of the steps of the planned demolition process. It would be expected that elements of each group are of the same nature, for a segregated management of the different materials and optimized material recovery. Similarly, elements should be disassembled, when possible.
In addition, this second tool provides recommendations on the equipment and tools needed for the removal of each building element, depending on the specific process planned. Moreover, onsite storage options can be evaluated for each waste stream, together with an eventual transportation to the final destination, in which the corresponding waste management process is applied.

**Conclusion**

A BIM based tool for supporting predemolition studies has been developed in the framework of a European project. The first functional version has been internally launched in March 2017. Along the same year its use will be demonstrated in several case studies around Europe with the participation of demolition companies, software developers, public bodies and RTD centers. The results are promising in terms of improving reliability and accuracy of materials quantification, facilitating the traceability of materials and quickening the evaluation of alternative demolition/recovery options.

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**References**