Digital life cycle management of architectural components through BIM-based Material Passports to improve circularity

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CONTEXT

In the context of an environmental crisis, the building industry is a major **consumer of raw materials and a producer of waste**. Therefore, the construction sector is the subject of various studies and actions aimed at encouraging it to adopt a **circular economy** (CE) approach [1-3]. In this context, **information** related to construction materials is **crucial throughout the building's lifecycle** [4-6]. The definition and maintenance of this information through "Material Passports" (MP) presents multiple opportunities [7-9], particularly concerning Building Information Modeling (BIM) practices [10-12]. In fact, we note that many initiatives to enhance the value of architectural components are in the process of emerging, and there are already several platforms linked to EC/PM. However, these platforms are not interoperable with existing softwares and tools, are often deployed on a small scale, and are not yet subject to standardisation norms due to the lack of coordination. The definition of these **BIM-based Materials Passports** (BIM MP) and their implementation are therefore still in the early stages [13] and are encountering a number of difficulties [14].

OBJECTIVES OF THE RESEARCH

The aim of the research project is to analyse the obstacles and levers involved in creating, processing, analysing, storing, sharing and managing the quality of digital data, in order to **encourage circularity through better monitoring** of building components. The assumption is that BIM MP meets the need for **data management and structuring**, as mentioned in the literature.

METHODOLOGY

By identifying, describing, and attempting to understand the obstacles and levers involved in managing digital data, the research methodology is based on **three distinct but complementary stages**: (1) analysis of current practices, identification of needs, obstacles, and levers; (2) proposed specifications for BIM MP; (3) development and testing of a BIM MP prototype compatible with existing tools (figure 1). Iterations are planned during the third stage to enable the prototype to be compared with the needs and demands of the sector and to be adapted (figure 2).

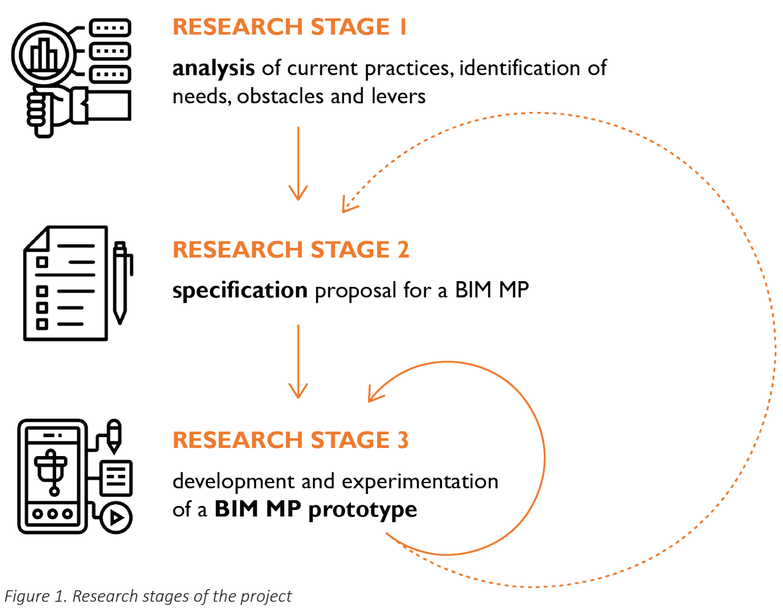
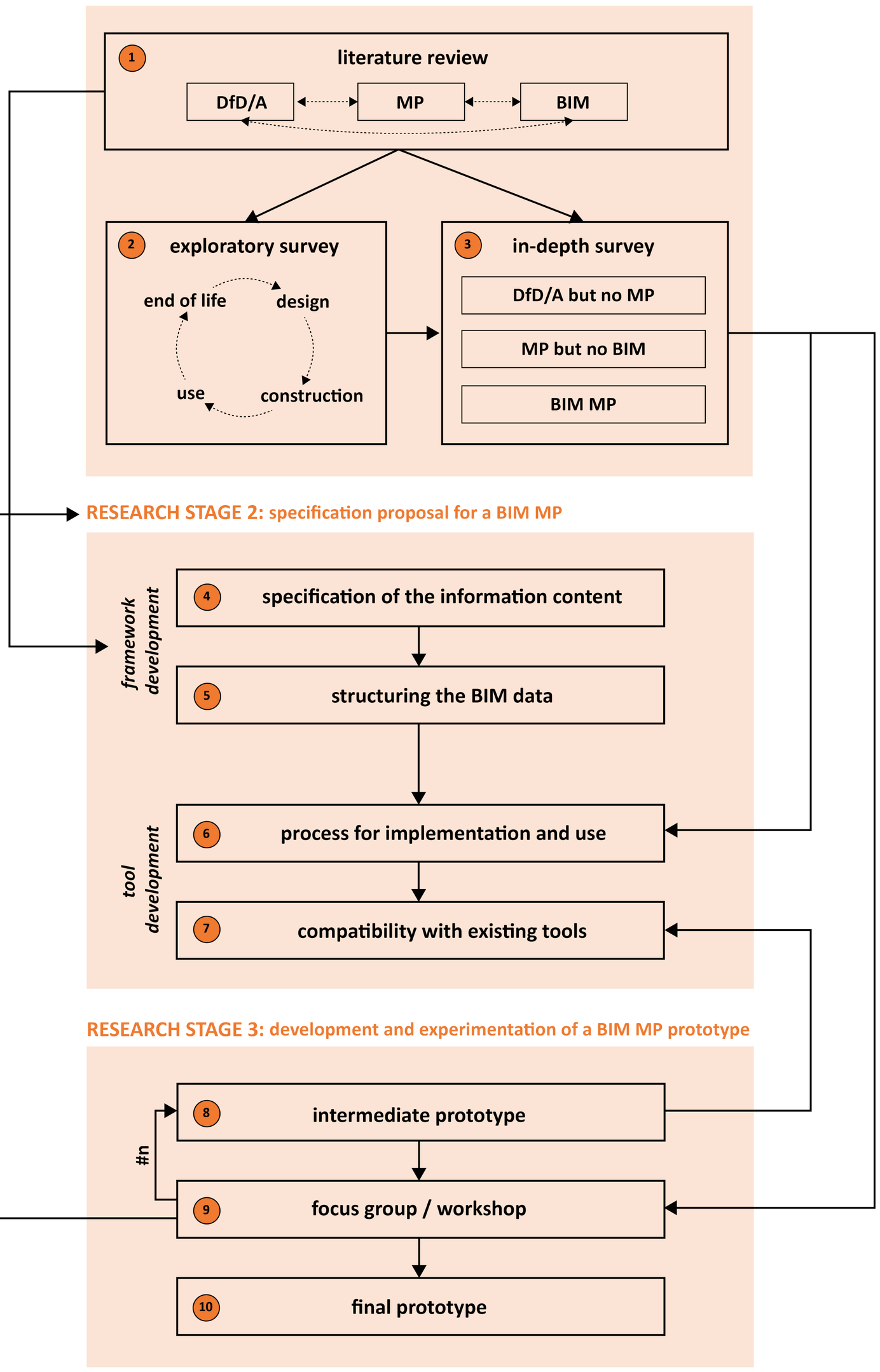


Figure 1. Research stages of the project



DfD/A : Design for Disassembly and Adaptability // MP: Material Passport // BIM: Building Information Modeling // BIM MP: BIM Material Passport

Figure 2. Methodology of the research project

Research stage 1

1. The **literature review** will analyse data management across the building's entire life cycle, from design to demolition, using MPs at every stage.
2. The **exploratory survey**, based on interviews using the Grounded Theory Method, aim to identify barriers and levers in digital data quality, understand collaboration and data exchange challenges among project stakeholders, and identify future case studies.
3. The **in-depth survey** involves the examination of case studies related to the integration of BIM PM. It analyses the content, structure, BIM standards, and industry practices, with a focus on data management.

Research stage 2

4. The **specification of the information content** of a BIM MP includes component characterisation information, traceability information, and sustainability indicators.
5. A thorough analysis of MPs' information needs will enable discussions about **structuring the BIM data**, such as the open IFC format and classification systems, as they provide non-proprietary solutions for data management during a building's lifecycle.
6. Based on findings from both the exploratory and in-depth survey, we will create a **process for implementation and use** of a BIM MP. The goal is to define roles in generating information, timing, and methods for accessing and using this information.
7. We will assess how our results align with existing MPs, examine their fit with BIM and LCA tools, and analyse data schemas and material databases for **compatibility with existing tools**.

Research stage 3

8. The **intermediate prototype** for this research project will be created using an agile approach, which emphasises iterative development and early delivery. This method encourages continuous improvement and responsiveness to stakeholder input.
9. Stakeholder input will be collected through **focus groups / workshops** in order to enhance and validate the prototype. The number of iterations will be determined based on the progress of our research.
10. The development of research conclusions will rely on the analysis and reflection of the **final prototype**.

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