Documenting for circularity through the lens of the Material Passport: Acceptability and perceptions of building information management

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Abstract. The transition to a circular economy in the construction sector depends on accurate, up-to-date information to facilitate material reuse. Material Passports (MPs) have emerged as a key tool to address existing information gaps, particularly when integrated with Building Information Modeling (BIM), which provides a digital infrastructure for data management. However, successful MP implementation hinges on stakeholder engagement. To explore stakeholder perceptions and acceptability, we conducted 18 semi-structured interviews with Belgian stakeholders representing different stages of the building lifecycle. Through our analysis, we found strong support for MPs among participants familiar with the concept, who viewed them as a promising mechanism for advancing material reuse. Five key motivations for MP adoption were identified: (1) enhancing material understanding, (2) documenting strategic project approaches and implemented concepts, (3) improving information accessibility and overall information management, (4) navigating through data overload and complexity, and (5) bridging theory and practice through demonstrative projects. While digital tools like BIM and AI are seen as critical enablers, concerns persist regarding their complexity, interoperability, and data reliability. By aligning stakeholder expectations with practical implementation strategies, this study provides actionable insights to support the effective integration of MPs into the stakeholders' workflows.

Keywords. Information Management, Circular Design, Material Passport, BIM, Digital Transformation

Résumé. La transition vers des pratiques circulaires dans la construction nécessite des informations fiables pour favoriser le réemploi des matériaux. Dans ce contexte, le Passeport Matériau (PM) s'impose comme un outil prometteur pour pallier cet enjeu, notamment lorsqu'il est couplé au Building Information Modeling (BIM). Le BIM constitue une infrastructure numérique potentielle pour la gestion des données qu'il contient. Toutefois, l'implémentation du PM dépend avant tout de l'adhésion des acteurs concernés. Pour évaluer leur perception et leur degré d'acceptabilité, nous avons réalisé 18 entretiens semi-structurés avec des acteurs du secteur belge couvrant l'ensemble du cycle de vie du bâtiment. L'étude met en évidence un fort soutien en faveur du PM, perçu comme un levier clé pour: (1) renforcer la compréhension des matériaux, (2) documenter les approches

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stratégiques des projets, (3) améliorer l'accessibilité de l'information, (4) naviguer dans des données complexes (5) illustrer le passage de la théorie à la pratique. Si les outils numériques tels que le BIM et l'IA sont identifiés comme des catalyseurs essentiels, des défis persistent, notamment liés à leur complexité technique, leur interopérabilité et la fiabilité des données. Cette étude identifie des pistes pour intégrer les PM dans les pratiques sectorielles, alignant attentes et gestion de l'information.

Mots clés. Information Management, conception circulaire, passeport matériau, BIM, transformation digitale

1 Introduction

Transitioning to a circular economy in the construction sector† is essential to addressing current environmental challenges [1–6]. A critical enabler of this shift is access to accurate, up-to-date information on construction materials throughout a building's life cycle [4, 7–9]. This information must reflect the actual condition of materials to support effective disassembly and reuse [4, 10–13]. The absence of such data today poses a significant barrier to the implementation of circular practices [7, 14–16].

One emerging solution is the Material Passport (MP), also known as a "product passport" or "circularity passport", which aims to address this information gap. The MP challenges the notion of waste as "material without an identity" by assigning value and identity to materials, thereby reclassifying "waste" as a resource [4, 8, 17]. Despite growing interest, there is still no universally accepted definition of MPs [16, 18]. Nonetheless, the BAMB project‡ defines them as (digital) datasets that describe the properties of materials and components in products, emphasising their value for use, recovery, and reuse. They serve as an educational tool, addressing circularity-related topics often missed by standard information management [4, 19, 20].

MPs are expected to evolve over a material's life cycle, acting as both repositories and communication tools that enhance reuse, repair, and recycling opportunities [8, 16, 20, 21]. Traditional information management tools are insufficient in this regard, making Building Information Modeling (BIM) a promising alternative [7, 15, 22]. BIM supports collaborative data management through digital models that combine geometric and semantic information [23–26]. However, current BIM strategies often do not include the necessary semantic data to disassemble and reuse the components [12, 15].

While BIM provides the technological infrastructure for data management and the MP offers a robust conceptual framework for material reuse, their successful implementation hinges on stakeholder engagement. Technological solutions alone are not enough. The long-term viability and impact of information management strategies depend equally on understanding the human roles, responsibilities, motivations, and perceptions that shape the construction

† The circular economy aims to keep the value of products and materials in use for as long as possible. In construction, it relies on three main pillars: (1) designing & building circularly (planning & concept, separating layers, choice of materials, assembly methods, etc.), (2) economic models (functional economy, sharing economy, extending lifespan, etc.), (3) urban mining (recycling, remanufacturing, reusing, deconstructing, etc.)(1).

‡ BAMB (acronym for "Buildings as Material Banks") is an EU Horizon 2020 promoting sustainability in construction. This project focuses on the development and integration of tools such as MPs and Reversible Building Design to facilitate this transition (19).

ecosystem. Gaining insight into how key stakeholders (such as project owners, architects, contractors and manufacturers) interact with and understand MPs is not only essential for their widespread adoption, it also helps us to build contextual knowledge on their implementation. This raises a fundamental question: *How are Material Passports perceived and accepted by stakeholders within the construction sector?*

This question is particularly relevant in the context of the 2025 edition of EduBIM, which focuses on the interplay between the (built) environment and digital technologies. Our contribution aligns with this theme by exploring how digital technologies, and specifically BIM-supported MPs, can contribute to mitigating the degradation of natural environments and living conditions. In this sense, BIM-supported MPs act as a digital mirror of the built environment: they embed a dynamic and adaptive dimension of information management that fosters material reuse. Our study is thus situated within the theme "BIM and sustainability," while intersecting with broader topics such as organisational models, BIM maturity, emerging roles, and evolving project practices. The concepts of self-organisation, complexity, and adaptability are therefore central to our reflection.

A distinctive feature of this research is the intersection of two historically distinct domains: circular economy practices and digital information management. The study focuses on stakeholders from the circular economy side, particularly those involved in DfD/A[§] projects. Stakeholders of the circular economy are not particularly known for their interest in digital tools such as BIM. Yet, we hypothesise that they are among the most motivated to document material flows to enable reuse. This tension makes their perspectives particularly valuable for understanding how MPs information management strategies might be adopted in practice. Accordingly, this research thus focuses on the human dimension of BIM and its related documentation and information management workflows. It aims to bridge the gap between technical tools and real-world implementation by examining stakeholder perceptions and fostering a more integrated, human-centered approach to information management in the construction sector.

2 Methodology

To capture this diverse range of perspectives and better understand stakeholders' perceptions of MPs, we adopt a qualitative approach to prioritise depth of understanding over numerical measurement [28]. The aim is not to quantify stakeholder acceptance, but to uncover how they interpret MPs within their specific contexts, the meanings they attribute to them, the challenges they encounter, and how these perceptions influence the practical implementation of circular strategies.

An abductive research design was chosen due to the evolving and often ambiguous nature of MPs. Indeed, ongoing debate persists about whether MPs should be conceived primarily as structured documentation (standardised datasets or records codifying the required information) or as digital tools (interactive platforms integrated into information systems to support decision-making across the material lifecycle). Yet, the boundary between these two conceptions is far from clear, as structured documentation can itself be digitalised and embedded into tools, while digital tools ultimately rely on structured data. This ambiguity fuels ongoing discussions about whether MPs should be integrated into existing information management systems or developed as standalone tools [18]. These uncertainties make traditional hypothesis-driven methodologies less suitable. Instead, this study builds theory

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[§] Design for Disassembly and Adaptability (DfD/A): *"design for disassembly and adaptability is a strategy to optimize both the service life and the design life"* (27) iteratively from stakeholder narratives, drawing on real-world insights, contradictions, and emerging patterns [28].

To explore these stakeholder narratives, we conducted 18 semi-structured interviews with Belgian stakeholders involved in DfD/A projects between June 2023 and January 2024. Participants were selected to represent the key stages of the building life cycle: Design & Planning (D), Manufacturing & Construction (M), Use, Operation & Maintenance (U), and Repurposing, Disassembly & Demolition (R), along with others (O) with broader or cross-cutting roles. Interview codes were assigned based on the stage of the life cycle in which each stakeholder is primarily involved (D, M, U, R, O), using a numerical identifier (e.g., D1, D2, M1), which are referenced throughout the following analysis.

A snowball sampling method [29] was used to expand the pool of relevant stakeholders for interviews conducted during research phases 2 and 3 (fig. 1). The snowball sampling was conducted based on the question, “Which stakeholders can facilitate Design for Disassembly and Adaptability?”, thereby referring to stakeholder roles rather than specific individuals. While this approach helped to capture stakeholders directly engaged in DfD/A practices, it may also introduce biases: participants are more likely to recommend stakeholders within their own professional networks, which can lead to overrepresentation of certain perspectives and underrepresentation of others. To mitigate this, we ensured coverage across all stages of the building life cycle and included stakeholders with both project-based and cross-sectoral experience.

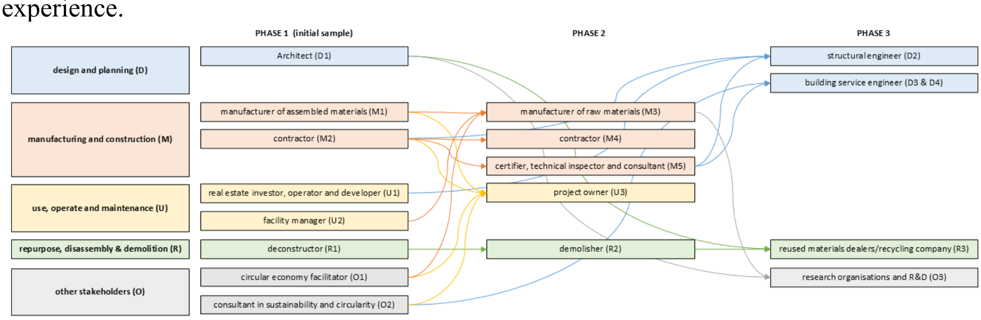

Fig. 1. Interview process based on the question “Which stakeholders can facilitate Design for Disassembly and Adaptability?” [30]

The interviews were carried out iteratively, allowing new insights to inform subsequent interviews (fig. 1). Given the relatively small sample size, transcripts were coded and analysed with an emphasis on qualitative interpretation over statistical generalisation. The analysis followed the methodology outlined in Lejeune’s manual [28], which prioritises narrative meaning and contextual depth. In qualitative data analysis, coding serves to identify and interpret key concepts, themes, and illustrative examples that address the research question [29, 31]. Coding was supported by the “Cassandre”** software, which also helped manage a researcher diary used to document analytical choices and reflections throughout the process [28, 32, 33]. The coding process enabled the identification of recurring observations and results (fig. 2), as well as the mapping of their interconnections (fig 3).

This contribution is part of a larger research project, and additional details regarding the methodology can be found in earlier publications [30, 34].

** Software « Cassandre »: https://www.cassandre.uliege.be/

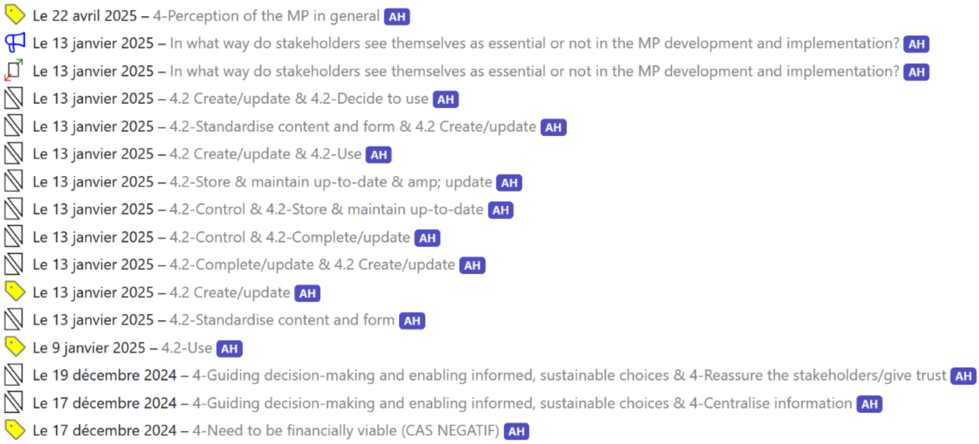

Fig. 2. Screenshot of the coding software "Cassandre" illustrating the coding process

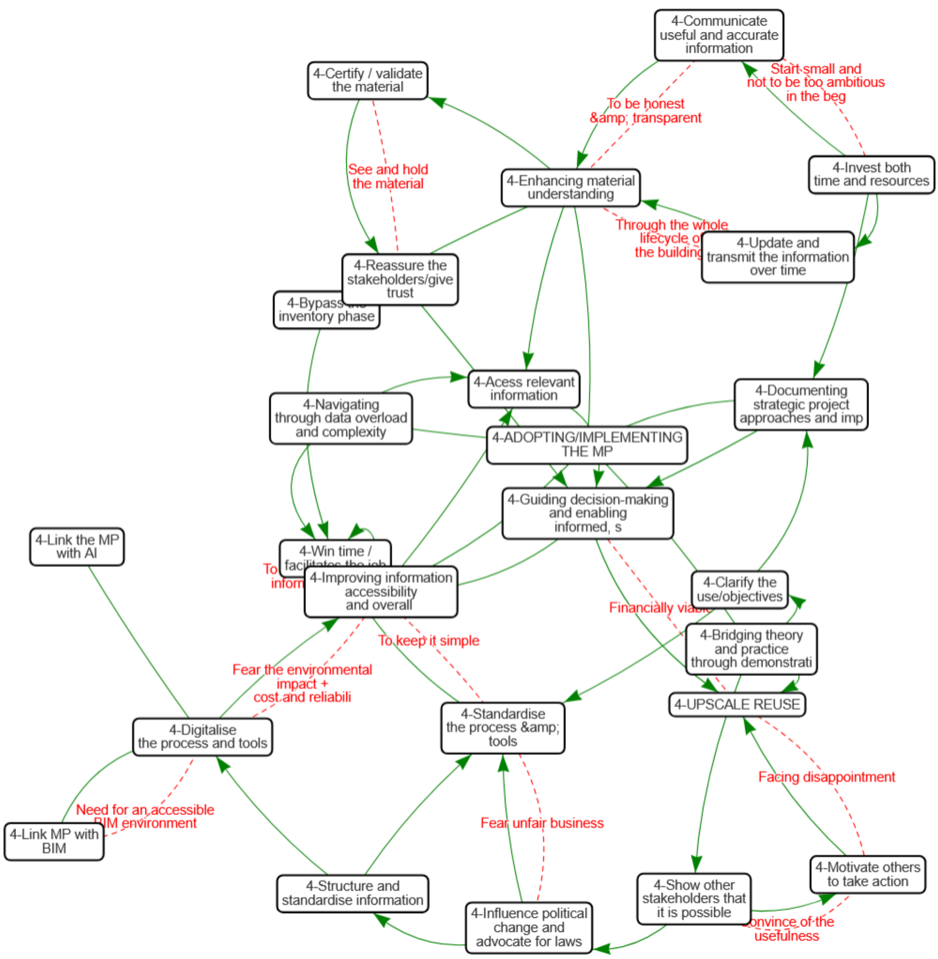

Fig. 3. Screenshot of the coding software "Cassandre" illustrating the mapping of the interconnections of the codes

3 Results

3.1 Shared perceptions of the Material Passport (MP)

Among the stakeholders familiar with the concept of MPs, there is generally strong support for their implementation across all lifecycle stages[D3, D4, M2, M3, M4, M5, R1, U1, U3, O1, O2, O3]. Many consider the MP as a promising tool to help the construction sector transition toward more sustainable practices[M1, M3, U1, U3, R3, O1, O2]. However, this potential depends on financial viability, a condition emphasised by nearly all stakeholders [D1, D2, D3, D4, M2, M3, M4, U1, U2, R1, R3, O1, O2] and supported by the literature [16]. A few others[D1, R3] expressed curiosity or openness, while some[D2, M1] had yet to encounter MPs in practice. A few interviewees[U2, R2] were unfamiliar with the concept. Notably, no interviewee voiced outright opposition to the idea.

Although stakeholders recognise the relevance of MPs, their views on its purpose and application vary significantly, revealing several key nuances. For example, some stakeholders[M5, R1, R2] associate MPs primarily with new materials rather than reused ones, even though the literature highlights the relevance of both [8,16]. These differing interpretations indicate that while interest in MPs is growing, their practical application is still unevenly understood [16, 21]. Such disparity often aligns with the stakeholders' respective life-cycle stages, highlighting the need for a clearer understanding of MPs' roles in practice.

While the primary objective of MPs is to support the scaling up of material reuse [4, 8, 16, 20], the stakeholders we interviewed also identified specific benefits aligned with their professional contexts. This contribution explores the diverse motivations behind stakeholder interest in MPs, showing how these drivers are shaped by distinct roles within the construction value chain.

Thanks to our coding technique (see section 2), five key categories of stakeholder motivations and perceived benefits regarding MPs emerged:

1. Enhancing material understanding,
2. Documenting strategic project approaches and implemented concepts,
3. Improving information accessibility and overall information management,
4. Navigating through data overload and complexity,
5. Bridging theory and practice through demonstrative projects.

These perceived objectives, and the ways stakeholders relate to them, are further explored in the following sections.

3.2 Enhancing material understanding

The drive to deepen material knowledge is widely acknowledged in the literature as a central motivation for the development of MPs [4, 7, 8, 16]. This focus even extends beyond the construction sector. Initiatives like the *Digital Product Passport* (DPP), who will accompany nearly all products sold in the EU in the future, aim to bridge the gap between consumer demand for transparency and the current lack of reliable product data [9, 21, 35–37]. Reflecting this broader trend, several interviewees[D2, D3, D4, M2, M5, U1, O3] emphasised the value of MPs, highlighting three key benefits of having access to accurate and relevant material information.

The first benefit relates to efficiency. Stakeholders report that access to relevant data for reuse helps them to save time and streamline tasks. Having (digital) access to comprehensive material information significantly reduces the time required for tasks like inventorying[D3] and, in some cases, even allows them to bypass these manual processes[U1, R3].

The second benefit centres on decision-making. When accurate and relevant material data is available, stakeholders feel it allows for more informed comparisons between different options[D4]. This information thus plays a crucial role in guiding material selection[D3, M4, M5, R2] and determining installation techniques[M5], while also ensuring that these decisions align with specific functional[D4, M5, R2] and performance requirements[D4]. Furthermore, such data is also valuable for future users (such as renovation teams or auditors) by helping them identify material characteristics and understand their application[D3], evaluate the potential to disassemble components without damage[D1], and support the reuse of materials without compromising quality[D2]. Additionally, detailed material information enhances evaluation of environmental impacts[M3], including CO_2 footprint assessments[M4].

The third benefit is trust, which is a recurring challenge noted in the literature [4, 8, 15, 16]. This trust in data is considered crucial for wider adoption[D2, D4, M1, M2, M5, U2, R1, R2], as individually testing each reused material is neither practical nor efficient[M5]. Furthermore, the literature also supports that reliable material data is not only vital for facilitating reuse but also plays a critical role throughout the entire building lifecycle [4, 7, 8] and in supporting BIM-based strategies in general [12, 38–40]. To ensure this trust, stakeholders highlighted two interdependent conditions.

First, stakeholders emphasise the importance of maintaining up-to-date information, such as installation plans or drawings, due to the risks posed by outdated documentation[D3, M3, U2, R2, O2, O3]. This challenge is widely recognised in BIM literature [24, 41]. Some stakeholders, especially from the manufacturing side, also emphasised the importance of version control and robust digital archiving systems, which they see as key to ensuring data remains accurate and accessible over time[O2, O3, M3]. In addition, the idea of tracking materials throughout the entire lifecycle of the building[D4] was cited by our interviewees as an important tool for improving the management of their condition and use[U2, R2]. In this view, traceability is not just practical but essential for ensuring that future changes do not negatively impact performance[U2]. This perception comes with an emphasis on the need for honesty and openness in the information provided[D1, M1].

In parallel, certification is perceived by several stakeholders as essential for ensuring compliance with safety and technical standards, particularly in applications where performance is critical, such as structural elements or insulation[M1, U2]. For instance, stakeholder D4 exemplified that having clear data on the thermal performance of reused windows could have enabled their use in high-value contexts, rather than limiting them to downcycling or lower-grade reuse. Beyond compliance, some view certification as a means to ensure consistency and reliability in data[D4, M1, M2, M5, U2], such as the varying thermal values reported in *Environmental Product Declarations* (EPDs) versus other certificates[M5]. Stakeholder D4 also highlighted certification's role in assessing material degradation over time and reducing the risk of misleading claims, such as falsely labelled "zero-carbon" concrete. Those who share this perspective argue that certified material data could provide the same level of confidence as conventional technical datasheets for new materials[M1]. However, the interviews reveal that not all stakeholders place equal trust in digital tools to ensure this certification. Some still prefer the reassurance of physically inspecting and handling materials[M4]. This divergence underscores a diversity of imaginaries in the field, pointing to an ongoing need for both digital and tactile forms of verification to accommodate varying expectations and practices.

3.3 Documenting strategic project approaches and implemented concepts

Stakeholders perceive the MP not only as a repository of material data but also as an information management strategy that captures essential aspects of a project's approach and implemented concepts, including maintenance procedures[M3, O3], adaptability scenarios[D3], (dis)assembly procedures[D1, D2, D3, D4, M3, R1, O3], and end-of-life scenarios[D1, D3, M3]. Although existing literature does not emphasise this strategic role [18], stakeholders repeatedly stress the importance of the MP for maintaining design continuity, particularly in renovation projects. Indeed, stakeholders report that access to original design intentions improves adherence to the initial concept in the new intervention[D1, D2, D3, D4, O2, O3]. As a result, the MP functions as a central communication tool[U3], allowing future users to understand project objectives and/or follow the intended maintenance procedures[O3, D2].

Unsurprisingly, it are mostly design-phase stakeholders who emphasise the MP's role in documenting strategic decisions, as their work requires deep building knowledge to propose coherent interventions on existing buildings. Meanwhile, operational-phase stakeholders stress the need to maintain information up-to-date (see section 3.2) and accessible (see section 3.4) throughout the building's lifecycle[U2, U3, O2].

Combining material data (see section 3.2) with documentation about the project's strategies, the MP thus emerges as both a practical toolkit for daily operations and a strategic decision-making tool for long-term governance[D4, M4, M5, R2, O2, O3]. These stakeholder insights are consistent with broader information management strategies and align well with frameworks such as the ISO 19650 series [25], reinforcing the MP's value as both a practical and strategic asset.

3.4 Improving information accessibility and overall information management

A commonly shared perceptions among interviewed stakeholders is that the MP has a strong potential to improve information accessibility through it's "centralisation", a term recurringly used by interviewees[D3, D4, M1, M2, M3, M4, M5, U3]. Centralisation is broadly viewed as a strategy to reduce data fragmentation[U3] and, consequently, lower the risk of data loss over time[D3].

While information management and BIM were not a central focus of the interviews, the stakeholders nonetheless demonstrated a notable alignment with its strategies and standards [25]. Indeed, several interviewees described the MP as a comprehensive, project-wide database for material-related information[D3, D4, U3]. Some stakeholders refer to the MP as a "material register" that offers deeper insights into building components and facilitates reuse planning[M3]. This "central repository" is expected to improve accuracy[D3, D4], transparency and trust[M1], provided there is a shared commitment to discipline and rigor in how data is handled (see section 3.2). In this context, the MP is primarily perceived as a practical information management tool that facilitates the efficient retrieval and sharing of critical project information. Stakeholders highlighted that a clear, consistent, and accessible approach to information not only streamlines workflows but also delivers widespread benefits across all stakeholders involved[D2]. The vision of a unified, structured framework that simplifies the process of data collection and sharing, thus emerged as a recurring theme[D1, D2, M3, M5, R1].

Notably, as previously discussed, stakeholders do not typically associate the MP directly with the BIM standard ISO 19650 series [25]. However, many interviewees did highlight the broader trend toward digitalisation, especially through the increasing use of BIM[D4, M2, M3, M4, M5, U1, U3] and/or artificial intelligence (AI)[M4, M5].

Even though we observe an implicit alignment between the overall expectation of the MP as an information management framework and the existing BIM ISO 19650 [25], there is no consensus on the digitalisation of the MP. This trend is most prominent among stakeholders engaged in the construction and operational phases. By contrast, those involved in repurposing or demolition tend to be less involved with these digital innovations.

The explicit adoption of digital strategies such as BIM is a point of both convergence and contention among stakeholders. Some view BIM as a key driver of innovation[D1, M2, M4, M5, U2], while others raise concerns about added complexity[D4, U3, O2], dependence on specialised expertise[O2], and the risk of excluding smaller or less experienced actors[O2]. A recurring concern among interviewees is the limited use of open-source solutions[M5] and thus the lack of interoperability between the tools[M5, O3], as this may limit transparency and collaboration[M1, M4, M5]. Stakeholders also cite persistent challenges with digital tools, including doubts about their reliability[M2, M4, U1, O2] and concerns regarding their environmental impact[O1]. Despite these concerns, the increasing use of digital BIM-related tools such as Aproplan[††], Dalux[‡‡], or Revit[§§] among the stakeholders[D1, D4, U1, O2] reflects growing recognition across the sector of the value of digital workflows.

In the literature, BIM is referenced as a foundation for integrated information systems, particularly in supporting design, construction, and commissioning stages [24, 25, 42]. Although BIM was not initially developed with the explicit purpose of facilitating future reuse, recycling, or circularity, both the interviewed stakeholders[D4, M2, M4, M5] and existing studies [7, 8, 13, 16, 22, 39, 40, 43–45], identify its significant potential in these areas. According to our interviewees, this potential is particularly evident when BIM is leveraged to:

- Automating repetitive tasks like material quantification[D4],
- Including material verification and lifecycle data in the as-built model[M2, M4],
- Embedding dismantling and end-of-life data[M5], and
- Improving project delivery efficiency by reducing post-completion adjustments[M4].

Across the sector, reuse practices are still largely in an exploratory phase[D4, R3, O1], with digital tools being trialled as part of the ongoing search for practical solutions[U3, R2]. To fully realise the benefits of digital information management strategies, stakeholders interviewed thus emphasise the need for more accessible and user-friendly BIM environments[U1]. Stakeholders thus highlight the need for continued research, development, and collaboration to ensure effective implementation[U1]. These insights align with the findings of Hoscheid [41, 42, 46], who underscores the importance of aligning technological capabilities with organisational workflows, stressing that without such integration, the benefits of BIM and other digital tools may remain theoretical rather than actionable.

In this context, the integration of AI is seen as a valuable enhancement by the interviewees. For instance, AI is perceived as a tool to optimise reuse platforms[M4], which are digital or physical services that facilitate the exchange or redistribution of second-hand products or materials [47].

Additionally, there is a shared view that the MP can streamline data entry and offer a holistic overview of materials from redeveloped buildings[M2]. This integrated perspective is perceived to enhance planning and resource management, including visions of linking demolition and renovation schedules to enable predictive resource planning and forecasting material availability [M2]. In this sense, AI is perceived as a means to forecast future material availability, thereby supporting more effective planning[M5].

Finally, several interviewees highlight that for digital strategies like BIM or AI to fulfil their potential in the context of MPs, they must be underpinned by structured and standardised data[D3, M3, U1, U3]. Current practices are often described as fragmented and inconsistent, which reduces overall efficiency and complicates the use of MPs[D3, U1]. Here again, these experts of circular design intuitively observed the foundational needs for better

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[††] Aproplan: https://www.letsbuild.com/lb-aproplan
[‡‡] Dalux: https://www.dalux.com/en-gb/
[§§] Revit: https://www.autodesk.com/products/revit/overview

information management systems, as it has been discussed in some areas of the construction industry for years [24, 46].

3.5 Navigating through data overload and complexity

Building on the need for robust data infrastructure, stakeholder perspectives reveal a shared recognition of the MP's potential as an effective tool for navigating through complex data, particularly for large-scale projects. However, opinions diverge significantly, both in the literature and in our interviews, regarding how this function should be realised. Some argue that the MP should serve as a comprehensive repository, consolidating all relevant information in one place [4, 7, 20, 39], while others argue that it should act more as a navigational aid, offering links to essential resources without embedding all content directly [9, 13, 16, 36, 40].

Across interviews, the MP was generally perceived as a federative tool, one that bridges the gap between summaries and detailed datasets by linking to more comprehensive documentation when necessary[U3]. This functionality would allow users to access pertinent information efficiently, reducing the likelihood of errors and information overload [8, 16].

In this regard, stakeholders view a standardised MP as crucial for four key reasons. First, it simplifies the process of data collection and sharing[D1, D2, M3, M5, R1]. Second, it clarifies the uses and objectives of a MP[D2, D3, D4, U3, O2, O3]. Third, it provides a universal language understood by all stakeholders, preventing miscommunication and ensuring consistency in information[D1, M3, M5]. Finally, it presents the data in an accessible and comparable format[M5].

In essence, stakeholders view a standardised MP as a coherent system that not only facilitates data sharing and reduces ambiguity but also enables sustainable construction practices by allowing better tracking, management, and reuse of building materials throughout their lifecycle[D2, U1, R1]. However, this expectation is challenging due to the diverse requirements of stakeholders across different s of the building lifecycle, inconsistent levels of detail, and the necessity for accurate information categorisation [8, 14–16].

Simplicity is also recurring theme, with stakeholders warning that overly complex or technical systems act as barriers to engagement[D3, U1, U3]. In contrast, tools that are clear, well-structured, and focused on essential information are generally seen as more approachable and likely to be integrated into practice[D1, D2, M1, O2]. However, a key challenge lies in distinguishing between essential and non-essential data[U1, O1], especially in systems like BIM, which, despite its potential to support material circularity, risks data overload[M3, U1, U3]. To mitigate this, stakeholders emphasise the importance of formalising criteria that define essential information, a critical step to prevent loss or misclassification[M3]. However, others expressed concern about the ambiguity surrounding how to establish these clear boundaries, pointing to a need for further reflection and coordinated effort in this area[D4, M1, M5, O2]. Recognising this inherent complexity of the challenge[R3, O3], some stakeholders advocated for starting small, with modest, achievable goals[D3, U1], a strategy also emphasised by the literature [8].

These discussions underscore a widespread demand for standardisation in both content and format. A central point of agreement is that clarity in purpose, content, and structure is essential for ensuring usability throughout a building's lifecycle[M1, O2]. Stakeholders broadly agreed that a well-defined framework could streamline processes[D1, D2, D4, M2, M5, U1, U2, R1, O2].

3.6 Bridging theory and practice through demonstrative projects

Some stakeholders have already begun implementing MPs without waiting for a fully streamlined process, arguing that demonstrating their practical value is a necessary first step. While detailed studies and theoretical frameworks on MPs exist [4, 8, 20, 40, 43, 48], stakeholders frequently point to a lack of practical examples and the disconnect between theory and practice[U1, R2, O3]. To address this gap, some stakeholders are proactively adopting MPs to prove their feasibility[M4, U1], aiming to accelerate the scaling of reuse practices. Their demonstrative efforts is driven by the conviction that tangible examples will have a stronger impact than theoretical models alone[M4, U1, O3].

However, convincing others remains a challenge, as MPs are often perceived as abstract tools offering long-term, rather than immediate, benefits[U1, O3]. This hesitation is reinforced by the perceived complexity and unclear data requirements associated with MPs[U1] (see section 3.5). Others question whether MPs genuinely add value[R1, O3], suggesting that in many cases, especially with older buildings, materials may be reusable without the need for a MP[O3]. Also, labelling materials of low quality, they argue, does not enhance their reusability[O3].

According to several stakeholders, demonstrating that MPs can be both feasible and beneficial is also a key step toward influencing political change and advocating for legislation that promotes reuse[D3, M4]. They see MPs as tools that can only reach their potential within a strong political and regulatory framework. Voluntary uptake alone is widely regarded as insufficient to bring about the systemic change needed[D3]. Stakeholders express support for mandatory measures, such as requiring a minimum percentage of reused materials in construction, which they believe would significantly enhance circularity[M5]. These measures would need to be supported by policies that ensure the availability of reusable materials, for instance through mandated demolition inventories shared on reuse platforms[M4]. Legislative backing, they argue, would also accelerate the development and standardisation of processes and tools[M2, M3, M4, U1, R1, O2].

Precedents for such measures already exist, including the *European Union's Circular Economy Action Plan* [3] and the *EU Construction and Demolition Waste Protocol* [49], which integrate reuse requirements and material traceability in the construction sector. These efforts could be reinforced by the MP [4, 8, 16, 39]. At the regional level, *Wallonia's Circular Economy Strategy* [6] exemplifies political commitment through policies promoting material circularity and reuse targets. Similarly, international standards such as ISO 20887 [27], provide a regulatory framework that supports circular building practices, particularly through DfD/A.

At the same time, there is concern among some interviewees that unfair business practices could arise in the mandatory use of MPs[M4, M5, U3, O1]. In particular, fears were raised about how lobbying and the influence of powerful actors, such as those involved in setting standards, might shape the regulatory landscape in a way that favours their interests[M4]. Some stakeholders noted that high participation fees of contributing to standards may lead to a system where only well-resourced stakeholders have influence or access[M4]. This raises concerns about inclusivity and fairness, especially if only larger players can afford to integrate the system[O1]. Such dynamics highlight the importance of transparent and inclusive policymaking to ensure that legislation promotes equitable access to MPs and reuse opportunities across the construction sector [16].

4 Discussion

The Material Passport (MP) is widely regarded in both literature [4, 16, 20] and stakeholder interviews as a promising information management tool to enable circular design, particularly in scaling up reuse of building materials. Existing research identifies several core motivations for the adoption of MPs, most notably the need to enhance material understanding, as well as to improve information accessibility and overall information management, often achieved through data centralisation [7, 8, 12, 43]. These aspects were also strongly emphasised by the stakeholders we interviewed, underscoring their relevance. Their significance is further reflected in the prominent attention devoted to them in the results section. Nevertheless, our findings reveal a broader set of perceived benefits that extend beyond the existing literature.

Stakeholders increasingly view MPs not only as repositories of information but also as valuable tools for documenting a project's strategic approach and implemented concepts, particularly in the context of DfD/A. Additionally, MPs are seen as practical instruments for navigating through data overload and complexity, helping users synthesise large volumes of (technical) information. A further motivation that emerged strongly from our interviews is the desire to set an example and bridge the gap between theory and practice, with several stakeholders highlighting the symbolic and demonstrative value of MPs in driving industry-wide change. Together, these five motivations (enhancing material understanding, documenting strategic project approaches and implemented concepts, improving information accessibility and overall information management, navigating through data overload and complexity, and bridging theory and practice through demonstrative projects) show a clearer and more practical view on the MP than has been previously articulated in the literature.

To move MPs from theoretical promise to practical impact, we argue that their design must intentionally reflect these broader objectives. By aligning MP development with these expanded functions, stakeholders can increase their perceived value and help overcome persistent adoption barriers.

Beyond passive documentation, MPs serve a dynamic role in information management [8, 16, 20, 21]. In interviews, MPs are often framed narrowly as "documentation", a term that, while capturing their archival function, reduces them to a passive repository. This perspective overlooks their broader potential to enable data-driven decision-making across a building's lifecycle. A more accurate and forward-looking conceptualisation is "information management," which better reflects their transformative role, particularly within BIM strategies. This shift is not merely semantic; it represents a critical evolution in how MPs are understood, from static records to active tools facilitating circularity.

Yet, realising this potential requires addressing standardisation challenges. Stakeholders generally perceive standardised MPs as a way to enhance clarity, ensure consistent information exchange, and establish a common language across the construction industry. Standardisation is widely seen as essential for reducing ambiguity, facilitating data sharing, and promoting sustainable construction through improved material tracking. However, realising this vision is complicated by divergent stakeholder needs, inconsistent levels of data detail, and challenges in accurately categorising information throughout the building lifecycle. A significant contributing factor is the varying degree of familiarity with digital workflows: stakeholders already using tools like BIM often see MPs as a natural extension of their practices, while others regard them as an added complexity. Rather than adopting a rigid, "one-size-fits-all" model, we argue for a flexible approach that clearly identifies stakeholder needs and integrates MP practices into existing workflows through targeted adaptations.

Several limitations of the present study should be acknowledged. First, the relatively small sample size does not allow us to generalise the findings. Future research would benefit from employing a quantitative approach to test these results on a larger scale. Second, the study is limited to the Belgian context. As patterns may differ across countries, further investigations could explore international variations. Third, the study did not include key stakeholders such as policymakers. Incorporating their perspectives in future research would offer deeper insights, particularly in light of ongoing EU-level developments that are likely to influence the adoption of the MP. These developments include major initiatives such as the *Digital Product Passport* (DPP), a cornerstone of the *Circular Economy Action Plan*; the *EU Taxonomy* for sustainable economic activities; and the *Level(s) framework*, which standardises sustainability performance metrics for buildings. Additionally, the upcoming *Ecodesign for Sustainable Products Regulation* (ESPR) aims to enhance product transparency and durability through digital means, while the revised *Construction Products Regulation* (CPR) is expected to mandate digital documentation. Future research should therefore be situated within this dynamic and evolving policy landscape.

5 Conclusion

This study explored the perception and acceptability of Material Passports (MPs) among construction stakeholders, particularly those involved in DfD/A projects. Although MPs are widely regarded as a promising tool for upscaling reuse, their adoption remains inconsistent across the sector, reflecting varying levels of stakeholder acceptability.

A key tension lies in the challenge of standardisation, a well-documented hurdle also encountered in BIM implementation. Both literature and stakeholders highlight the need for standardised frameworks, yet their specific information requirements differ significantly. This divergence suggests that a rigid, "one-size-fits-all" approach is unlikely to succeed. Instead, we argue that future MP development should prioritise interoperability while retaining flexibility to accommodate diverse stakeholder needs.

Notably, this research reveals a disconnect between two key groups: circular economy practitioners (especially those focused on reuse) and digital/BIM experts. Reuse-driven stakeholders, while highly motivated to document material flows, often overlook the potential of digital tools like BIM to streamline information management. Conversely, BIM specialists may not fully grasp the demands of circular construction. Bridging this gap is essential, as both groups face shared challenges, such as standardisation and data reliability. Facilitating cross-disciplinary dialogue could unlock synergies, ensuring that MPs evolve as technically robust and practically viable solutions.

Ultimately, the success of MPs depends not only on technological progress but also on aligning stakeholder perceptions, workflows, and incentives across the construction ecosystem.

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